DOES ROAD-SPACE REALLOCATION AFFECT NETWORK VKT?

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ABSTRACT

Road-space reallocation (RSR) is the re-purposing of existing road space from general traffic to active or public transport modes; this could affect road corridor elements such as traffic lanes, parking lanes, cycle lanes, bus lanes, and footpaths. Recent research for NZTA by ViaStrada investigated the impacts of permanent RSR on measured network vehicle-kilometres travelled (VKTs), and associated common factors observed.

The work involved a systematic review of relevant local and international case studies and other literature, identification of factors required for successful and sustained implementation of network VKT reduction from RSR, assessment of the impact of RSR on the NZ Transport Outcomes Framework components, and determination of recommended best practice.

The review found strong evidence that road-space reallocation interventions reduce road congestion overall, and moderate evidence that they reduce it network-wide. It also found evidence of reductions in motorists' mean speed, increases in active transport modes on roads where interventions have occurred, and improved road-user safety.

Projects where multiple streets or a key strategic link (e.g. bridge or tunnel) were affected by RSR interventions were found to be most effective in reducing network VKTs. Also effective were projects incorporating new walking/cycling facilities, modal filtering elements, or where a traffic or parking lane was removed. Less effective projects appeared to be ones where there were also greater issues with public engagement and consultation.

Road-space reallocation best practices that might be implemented in NZ to support network VKT reduction include involving multiple streets as part of a network-wide treatment, getting good engagement and data upfront, looking at the relative changes to users of other modes, and having a nearby "control site" to determine whether traffic has "disappeared" or simply diverted to other streets. It was noted that many of the best practices identified related more to project processes rather than the actual physical infrastructure.

This paper summarises the tasks undertaken, the resulting findings, and recommendations for best practice going forward.

INTRODUCTION

Road-space reallocation (RSR) is the re-purposing of existing road space from general traffic to active or public transport modes; this could affect road corridor elements such as traffic lanes, parking lanes, cycle lanes, bus lanes, and footpaths. Various design and policy tools can be applied to these elements, broadly categorised as:

- adding or removing an element
- reducing the size of an element
- sharing space (either always or at different times)
- removing a road-user group (either always or at different times).

Some examples of permanent RSR could include:

- removing on-street parking to widen a footpath
- narrowing traffic lanes to add a cycle lane
- providing on-street parking that reverts to a bus lane during peak hours.

Recent research for NZ Transport Agency (Waka Kotahi) by ViaStrada investigated the impacts of permanent road-space reallocation on measured network vehicle-kilometres travelled (VKTs), and associated common factors observed.

The objectives of the research were to:

a) systematically review and conduct a meta-analysis of relevant national and international studies with measured impacts of permanent RSR and measured levels of network VKT reduction
b) identify the factors required for successful and sustained implementation of network VKT reduction from permanent RSR
c) assess the impact of permanent RSR on the five outcomes in the NZ Ministry of Transport's *Te Anga Whakatakoto Hua Mō Ngā Waka: Transport Outcomes Framework* (Ministry of Transport 2018)
d) recommend best practice that might be implemented in New Zealand to support permanent RSR for network VKT reduction.

This paper summarises the tasks undertaken, the resulting findings, and recommendations for best practice going forward. For more information, refer to the research report and accompanying research database (Koorey *et al.* 2025).

SYSTEMATIC LITERATURE REVIEW

A comprehensive literature review identified 30 New Zealand and international references to case studies deemed relevant to this study and where some street reallocation took place and measured impacts were captured. Over 40 other references were also identified relating to aspects of success factors, transport outcomes, practical recommendations, and general issues. Refer to the report and database for the full list of references reviewed.

Most of the list of references was obtained from an online search of different databases, such as NZTA research reports, relevant journals and conference contributions (e.g., *Transportation*; *Journal of Transport & Health*; *Transportation Research Parts A/B/C/D*; the Transportation Research Board's TRID database, etc), and reports published by councils or relevant transportation organisations. While the review included older sources with multiple cases (e.g. Cairns *et al* 2002), we also identified two very comprehensive more recent ‘rethinking streets’ compilations of case studies from North America by Schlossberg *et al.* (2013) and Schlossberg *et al.* (2019), which provided some useful data points.

The studies were each evaluated in terms of their:

- research evaluation **reliability** (assessed in terms of multi-modality, scope of impacts/outcomes measured, and area evaluation level),
- **relevance** to New Zealand conditions (assessed in terms of urban population density and road network “personality”), and
- assessed **effectiveness** in terms of reducing network VKT (from “no effect”, to “minor effect” and “major effects”).

While many studies did not directly measure VKT reduction, various other related impacts were measured (including traffic volumes, mode shift, safety impacts, and environmental metrics) and could be interpreted as indicators of VKT reduction. All of these indicators were recorded in the resulting research database, a spreadsheet capturing all of the case studies investigated, as well as all literature references reviewed.

Although the stated focus of this research was on “permanent” road-space reallocation treatments, there are potential lessons also to be learned from treatments that have been installed on a *temporary* basis (for example, as part of street trial works during Covid lockdowns, or as part of initiatives like NZTA’s “Streets for People” programme). Some projects investigated may also (initially, at least) be constructed using low-cost materials that are faster to implement and allow for easier reconfiguration during a trial period.

Following the literature review, graphical summary profiles were also created for each case study (see Figure 1). Each profile provides a brief exposition of the applied interventions, targets and measured impacts, as well as the calculated indexes, such as relevance to New Zealand. While detailed information about each case study is provided in the separate research database, the main purpose of creating a profile for each case study was to provide a quick overview of the case studies for readers.

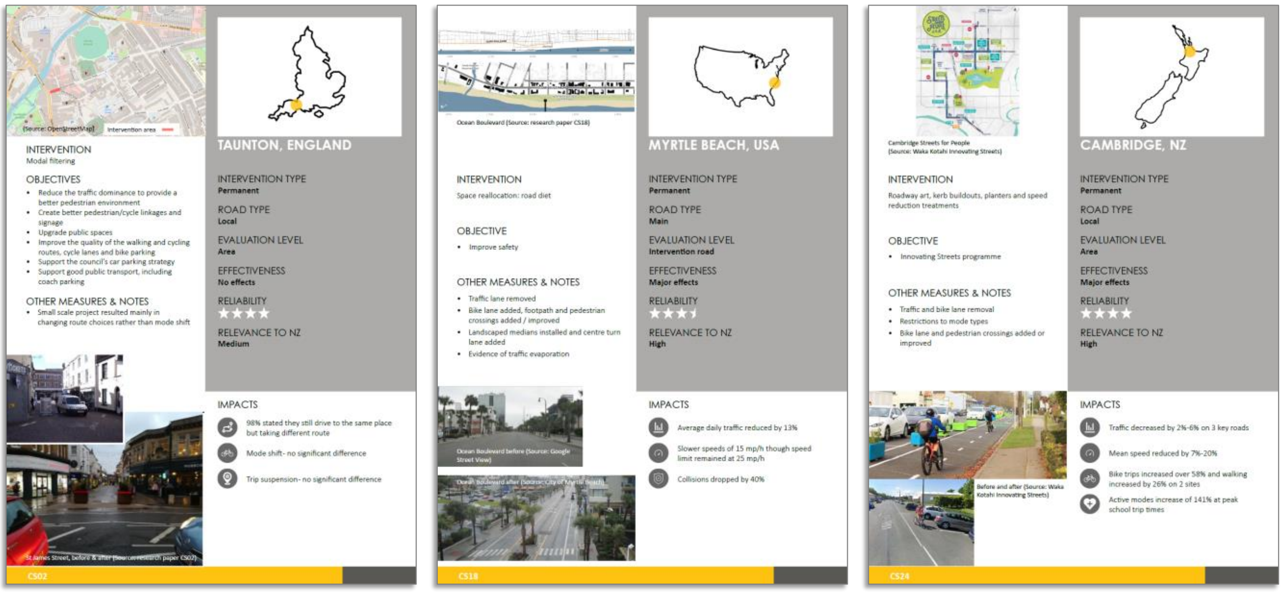

Figure 1: Some sample case study graphic summaries from England, USA, New Zealand

Key findings of the Literature Review

The findings of this review included the following:

- There is strong evidence (from almost all case studies that measured it) that the interventions reduced road congestion inside treated areas, and moderate evidence (from some case studies that measured it) that they reduced network-wide congestion. The international cases did not, however, include any cases with high relevance to the New Zealand context given the size and scale of congestion in the international cases. More international research is required to quantify the effects on road congestion.
- There is moderate evidence (from some case studies that measured it) of mean speed reduction. All of the case studies that reported speed impacts found that the intervention led to a reduction in speed both at a network-wide level and the roads where the intervention took place. Most of the case studies involved reallocating space to a cycle lane and were assessed to be highly relevant to New Zealand.
- There is strong evidence (from most case studies that measured it) of an increase in active travel on roads where interventions occurred. Only some of the studies measured desirable mode shifts from cars to active modes, and these were in less relevant central city areas with high population densities.
- Attempts were made to measure the route choice effects of RSR interventions in six case studies, none in them in New Zealand cities. No trend can be discerned from the observed measurements.
- There is strong evidence (from most case studies that measured it) that safety was improved by RSR interventions, either through measured crash data or the safety perceptions of road users. Most of these cases only included measurements from the intervention road. The literature is unequivocal in finding a strong safety benefit from certain RSR interventions, such as “road diets” (i.e. traffic lane removals).
- The emission impacts of RSR interventions have only been measured in three overseas case studies. Though the evidence is not enough to conclude any area-wide trend, all the cases reported a reduction in some emission indexes, such as $PM_{2.5}$, CO, CO_{2e}, and NO_2.
- A few case studies showed improvements in different physical- or mental-health-related factors, such as pedestrian activity, increased dwelling times (seating), and active mode use around schools at peak travel times.

Research on induced road traffic in New Zealand

Another piece of research recently completed in New Zealand (Byett *et al.* 2024) investigated how to assess induced road-traffic demand. While that work focussed on what factors contribute to inducing additional traffic on road networks and how to measure the level of change, some of the lessons gleaned from that research could also be applied when considering the *opposite* process (i.e., how to reduce traffic). However, it needs to be acknowledged that the potential changes up and down are not necessarily symmetrical in terms of the level of change made and the subsequent observed effects.

Byett *et al.* (2024) use standard transport economic theory to explain the underlying cause of induced traffic. In this theory, the amount of travel by a given transport mode is related to the relative cost of travel. A ‘supply’ curve represents the available capacity of a transport facility, and typically the cost per user increases as more people use it (as seen when roads are congested). A ‘demand’ curve represents the amount of travel that people will make; typically, more people will travel (or travel further) if their costs are less (e.g., fuel prices reduce, traffic obstructions are reduced). The intersection of these two curves is called the ‘equilibrium’ point and represents the likely amount of travel that will occur for a particular supply/demand combination.

The opposite effect can result in reductions in the observed traffic, as illustrated in Figure 2 (based on the original equilibrium curves by Byett *et al.*). Road-space reallocation measures (such as removing a traffic lane or redirecting traffic to other routes) can increase the relative cost of travel, shifting the supply curve upwards. Therefore, the shifted equilibrium point is likely to reflect reduced levels of travel. One interesting scenario is when this occurs while normal traffic growth is still continuing, due to external influences such as population change. As indicated in the diagram, it may be that the observed reduction in travel understates the actual reduction attributable to road-space reallocation, due to the countering effect of normal traffic growth. It is quite likely therefore, that any observed reduction from such measures is conservative.

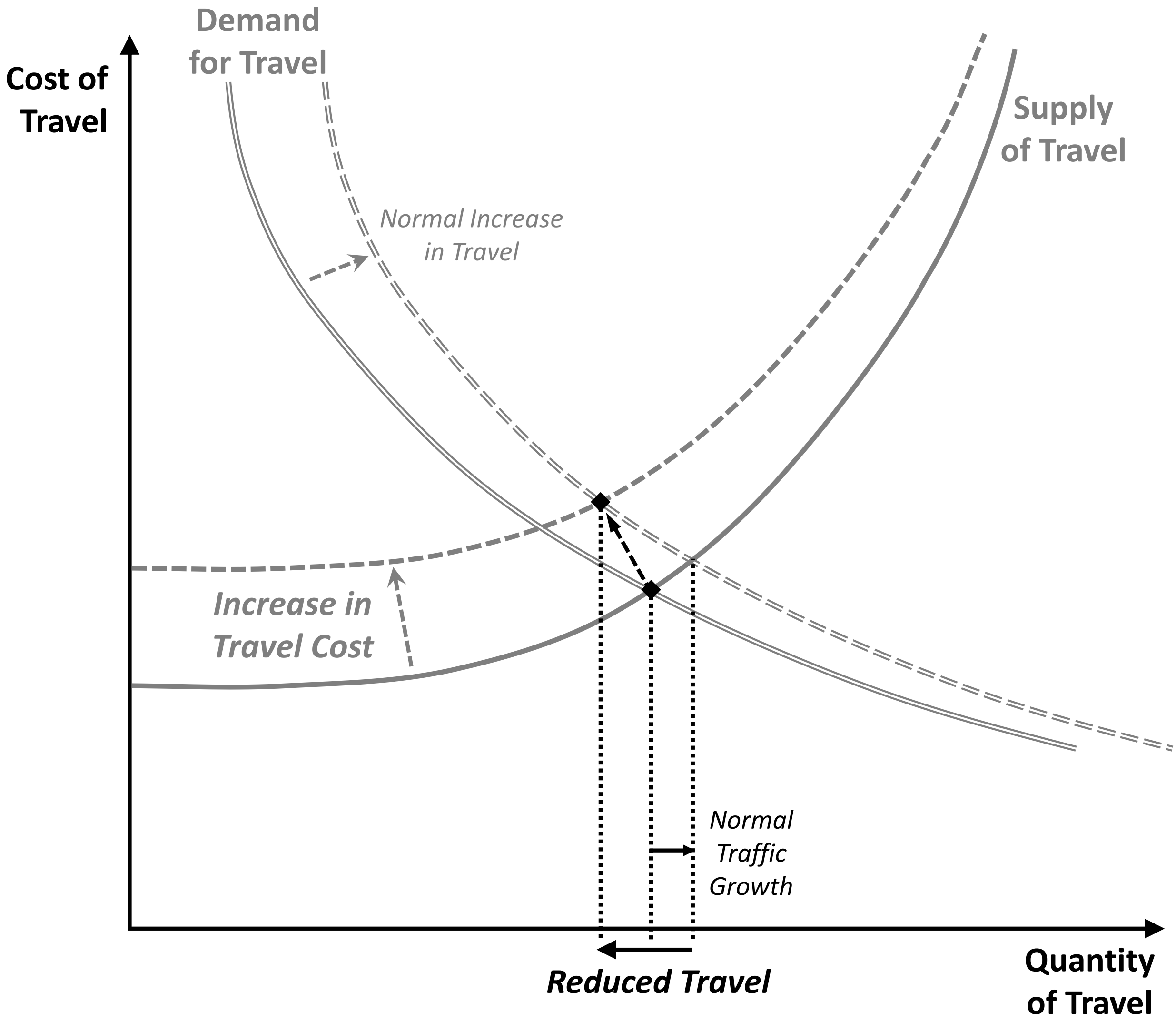

Figure 2: Reduced travel demand as explained by transport economic theory (based on Byett et al. 2024)

Byett *et al.* (2024) collated a number of general insights identified from their research and modelling to inform assessments of induced road-traffic demand. Many of these insights are equally applicable when considering the converse scenario of traffic reduction:

- A cost change is a necessary condition for induced traffic, and this can also apply for reduced traffic. However, capacity changes (e.g., new lane-kilometres) are not a necessary condition for induced traffic unless they create cost changes (e.g., traffic was already near capacity). If fewer lane-kilometres are provided and this does not create a cost change (e.g., because the road is not very busy), there is unlikely to be any reduced traffic.

- The quantity of induced (or reduced) traffic depends on local transport conditions. Different quantities will be induced (or reduced) depending on congestion, substitutability of a new link and the capacity of other links in the network. Any analysis of a road-space reallocation project needs to understand the wider context of what has been changed and how the surrounding network can respond to that.
- The quantity of induced (or reduced) traffic depends on the scope of analysis, for example traffic on a new road, total traffic in a corridor, total traffic in a suburb or city, total traffic in a region or all of New Zealand. Typically, a localised measure will have a decreasing effect on the surrounding area the further out one goes.
- Land-use changes can be an important contributor to the level of traffic on a road. Whether traffic is induced or not depends on the displacement of previous land-use locations. Certainly, they may be part of observed long-term changes to VKT patterns.
- Induced traffic effects vary considerably, from extremely large increases to very small ones. It is likely that different projects attempting to change VKT will also result in varied outcomes, and background traffic growth will also mask the actual changes that have occurred.
- It is difficult in empirical ex-post (after) analysis to distinguish between background growth and induced traffic; it seems that induced traffic can be around 25% of background traffic growth. If there is a similar scale of effects when considering traffic change, it may be that even a minor VKT change (or little observed change at all) actually implies a good level of traffic change from what there would have been.
- Responsiveness to road-space reallocation is likely to differ during different periods of the day, and this may vary by context – it may require an assumption about the period of the day likely to be most sensitive to travel cost. For example, there may only be noticeable impacts on traffic and parking during peak-demand periods, but relatively minor effect at most other times.
- There is very little New Zealand research on induced demand to apply, so reliance is required on the transfer of knowledge from international research. Much of the evidence relied on in this study comes from overseas examples of road-space reallocation, although more recently there have been some local examples as part of recent street-reallocation projects.

Byett *et al.* (2024) reviewed various overseas studies of demand elasticities with respect to increasing road capacity. At a relatively local level, the average long-run elasticities varied by the type of road (e.g. from busy urban motorways through minor rural roads). These elasticities may not apply to road-space reallocation for reductions in road capacity (or to increase travel costs), but if the elasticities are symmetrical then the estimated changes in VKT could also be inferred using elasticity measures. For example, a 1% increase in average travel costs (due to extra travel time or delay) on non-arterial urban roads could produce a 0.6% reduction in VKT in the long run. However, as mentioned earlier, there may not necessarily be symmetrical effects, up and down, for changes in travel costs and their resulting effects on VKT.

SUCCESS AND FAILURE FACTORS FOR VKT REDUCTION

Analysis of the literature identified several factors required to achieve successful and sustained network VKT reduction from permanent road-space reallocation. In terms of different physical treatments, the following features were reported more frequently in the case studies that were rated most effective (in terms of VKT reduction):

- Multiple streets affected as part of a network treatment; or alternatively, a project affecting a key strategic link (e.g., a bridge or tunnel) that has impacts on the surrounding street network.
- Walking and cycling facilities (typically a new or widened footpath or separated cycleway), usually created from the removal of traffic or parking lanes.
- Improved pedestrian crossing facilities included as part of a street-enhancement project.

- A high use of street landscaping measures, including planters, street trees and vegetation, road art, etc.
- Modal filtering elements (i.e. physical measures preventing passage for motor vehicles).
- The removal of a traffic lane or a parking lane to help provide additional space for other road users, with the removal of the former being more effective at reducing VKT.

The less effective case studies appeared to be ones where there were also greater issues with public engagement and consultation, although it was not easily possible to discern the relative technical merits and appropriateness of each proposed case study.

In addition to the physical features conducive to successful network VKT reduction, eight categories of non-infrastructure factors were also identified as critical to the success or failure of many RSR projects (particularly in the short term). These were based on a previous road-space reallocation study for Auckland Transport (ViaStrada, 2021). They include:

1) political support by key elected leaders and champions, often with advocates helping to build momentum
2) public engagement done well throughout the process, and clearly framed proposals
3) strategic alignment with high-level objectives and network priorities that have previously been agreed on
4) methodical and collaborative planning and design that transparently address comments and objections
5) programme governance that has the right people, skills, and continuity, often with the same staff and communications team providing direction and support throughout
6) resources and capability available to equip practitioners with the skills to communicate difficult subjects with the public and to balance project funding and timing constraints
7) a fast approach to delivery to enable the public to see results before opposition can spread, and to allow treatments to be quickly changed or removed if need be
8) community support and acceptance built up with stories of success and community activities.

The success of some initiatives studied may of course be very specific to a certain location or the conditions of the local jurisdiction, infrastructure, or culture. As a result, there may be caveats that limit the relative success of a similar implementation in New Zealand, or identify the additional conditions that would need to be present to achieve similar sustained change.

Not all projects reviewed resulted in any effective change in VKT. While the above discussion is focused on the key contributing factors, it is also important to highlight ‘detracting factors’ as well, as indicators of what *not* to do. In many cases, these simply represent the opposite of, or the absence of, the key factors. Sometimes this is based on people feeling like they have ‘lost’ something, which is often felt more keenly than any ‘gains’.

TRANSPORT OUTCOMES FRAMEWORK REVIEW

The Ministry of Transport’s *Transport Outcomes Framework* (Ministry of Transport, 2018) provides an overarching set of desirable outcomes to be achieved from transport policies and projects. The five outcomes cover inclusive access, healthy and safe people, economic prosperity, resilience and security, and environmental sustainability. Figure 3 summarises the key principles behind each transport outcome.

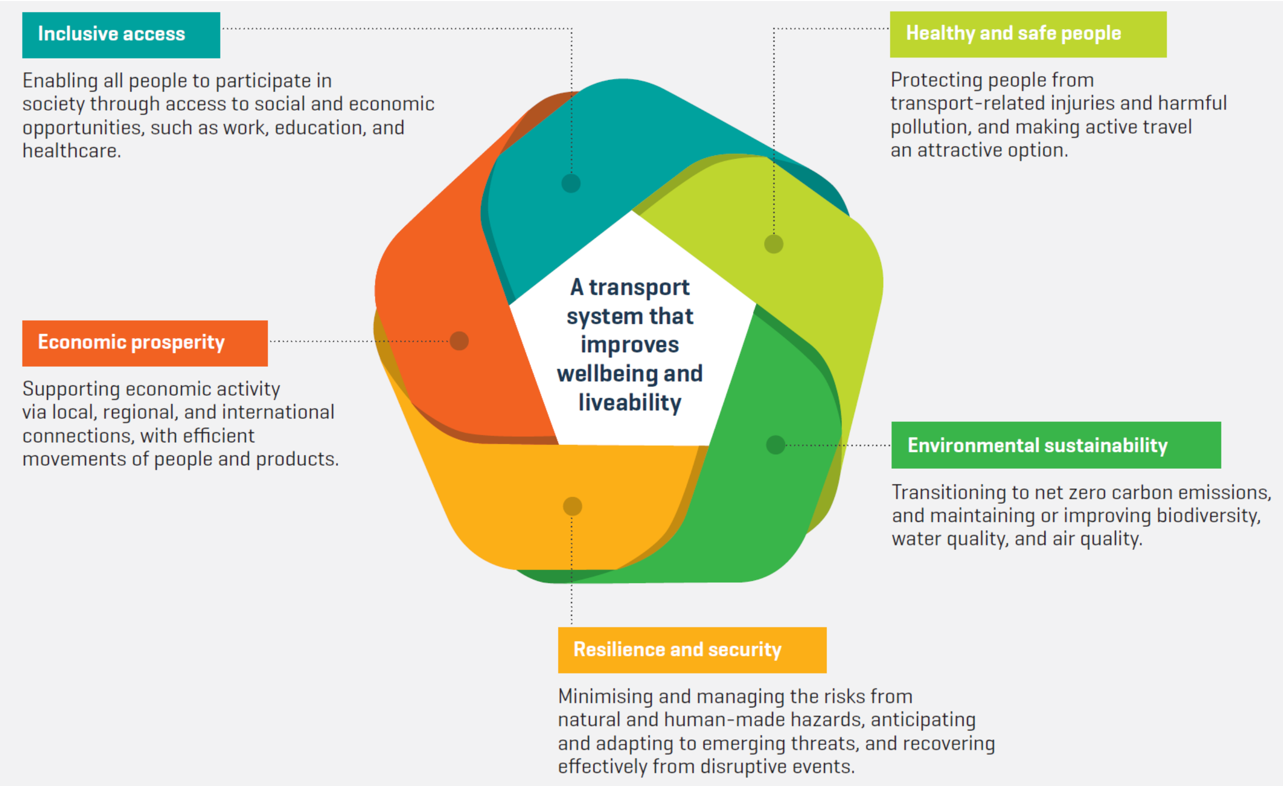

Figure 3: Transport Outcomes Framework (reprinted from Ministry of Transport, 2018, p. 16)

Guided by the findings of our literature review, we assessed the various options for permanent road-space reallocation against the five transport outcomes to determine whether:

- the reallocation initiatives affect some outcomes much more than others
- the impacts of reallocation are positive for every outcome.

It should be noted that this research was conducted under a previous policy context of the 2021-2024 *Government Policy Statement (GPS) on Land Transport*. So, while the transport outcomes reviewed below largely aligned with that GPS, they may not be as applicable to the transport policies, legislation, and initiatives that have been introduced or implemented since.

NZTA's *Land transport benefit framework overview table* (Waka Kotahi NZ Transport Agency, 2023) provides an overview of how to map the five transport outcomes against various quantitative and qualitative measures (which combine to contribute to various stated benefits). The various individual benefits contributing to each outcome were assessed in terms of the expected immediacy of their effects – short, medium and long term. For example, a bus lane may have a more immediate positive impact on system reliability for bus passengers, while the resulting changes to travel patterns by motorists may still take longer. Table 1 summarises the respective assessments made.

Transport outcomes	Benefit cluster	Benefit	Effect type
Healthy and safe people	1. Changes in user safety	1.1 Impact on social cost of deaths and serious injuries	Short term
		1.2 Impact on a safe system	Medium term
	2. Changes in perceptions of safety	2.1 Impact on perceptions of safety and security	Short term
	3. Changes in human health	3.1 Impact of mode on physical and mental health	Short term
		3.2 Impact of air emissions on health	Short term
		3.3 Impact of noise and vibration on health	Short term
Resilience and security	4. Changes in impact of unplanned disruptive events on access to social and economic opportunities	4.1 Impact on system vulnerabilities and redundancies	Medium term
Economic prosperity	5. Changes in transport costs	5.1 Impact on system reliability	Medium term
		5.2 Impact on network productivity and utilisation	Long term
	6. Wider economic impact	6.1 Wider economic benefit (productivity)	Long term
		6.2 Wider economic benefit (employment impact)	Long term
		6.3 Wider economic benefit (imperfect competition)	Long term
		6.4 Wider economic benefit (regional economic development)	Long term
Environmental sustainability	7. Changes in natural environment	7.1 Impact on water	Long term
		7.2 Impact on land and biodiversity	Long term
	8. Changes in climate	8.1 Impact on greenhouse gas emissions	Short term
	9. Changes in resource efficiency	9.1 Impact on resource efficiency	Medium term
Inclusive access	10. Changes in access to social and economic opportunities	10.1 Impact on user experience of the transport system	Short term
		10.2 Impact on mode choice	Short term
		10.3 Impact on access to opportunities	Medium term
		10.4 Impact on community cohesion	Long term
	11. Changes in liveability of places	11.1 Impact on heritage and cultural value	Long term
		11.2 Impact on landscape	Long term
		11.3 Impact on townscape	Medium term
	12. Changes in te ao Māori	12.1 Impact on te ao Māori	Long term

Table 1: Assessment of term effect types of RSR on different transport outcome benefits

Based on the assessments above, the various metrics identified in the case study database discussed earlier were related to the five transport outcomes as follows:

- traffic volumes – inclusive access
- average speed – economic prosperity
- average travel time – economic prosperity
- VKT change – inclusive access
- trip suspension – inclusive access
- departure time – resilience and security
- route choice – resilience and security
- mode shift – inclusive access
- safety – healthy and safe people
- emissions – environmental sustainability
- health – healthy and safe people.

Even these categorisations are subject to interpretation of what constitutes a positive or negative change for a metric. For example, average speed increasing could lead to an increase in economic prosperity but a decrease in safety.

Each of these metrics were then reviewed to see what types of RSR treatments were most effective relative to the five transport outcomes. The outcomes of *'healthy and safe people'* and *'inclusive access'* were found most likely to see immediate (or medium-term) effects from RSR measures, with the 'economic prosperity' outcome assessed as being likely to see effects only in the long-term.

BEST PRACTICE FOR NETWORK VKT REDUCTION

Taking on board all the above investigations and analyses, we have identified some best-practice measures for road-space reallocation that are most likely to result in network-wide VKT change. These measures include:

- Have trust in the evidence directly relevant for anticipating the likely effects of a proposed project, while identifying and adjusting for any local differences. While some case studies have shown only limited or negligible effect in achieving VKT change, it is notable that virtually *none* appeared to produce serious adverse impacts in increasing VKT (at least at the local-intervention street level, even if there is evidence of traffic redistribution to nearby streets).
- Involve multiple streets as part of a network-wide treatment (or alternatively a key strategic link like a bridge that has impacts on the surrounding street network). The most effective RSR projects tended to involve multiple streets as part of a network-wide treatment (or alternatively a key strategic link, like a bridge, that has impacts on the surrounding street network).
- Focus also on the *qualitative* project processes (e.g., communications, political support, staffing, and governance), rather than just what is actually physically being built (i.e., infrastructure changes). It is generally worthwhile to spend more to get good engagement, data, and evidence upfront, to save any subsequent rework or debate.
- Look at the relative changes to users of other modes, and have a nearby untreated 'control site' to determine whether traffic has actually 'disappeared' (as described in Cairns *et al* 2002) or simply diverted to the surrounding network. This is important to separate out any changes in network VKT that may occur in conjunction with other broader changes in travel demand (e.g., additional travel increases due to population growth).

- Identify useful tools for modelling road-space reallocation options that are available. For example, while not featured in any of the case studies, the European MORE (**M**ulti-modal **O**ptimisation of **R**oad-space in **E**urope) project (European Commission 2023) shows promise as a potential toolset for use in RSR project evaluations in New Zealand. MORE includes four web tools to assist street design:
  - an option generation tool, including a library with design elements to develop new options
  - a stakeholder engagement tool for the co-creation of design options, using web-based (LineMap and Traffweb) and traditional planning tools
  - a simulation tool (based on an update of Vissim) that mimics user behaviour in streets and on roads, including the delivery of performance indicators
  - an appraisal tool for the assessment of design options.

CONCLUSIONS AND RECOMMENDATIONS

This review of road-space reallocation has attempted to identify factors for successful measured and sustained network VKT change and to develop best-practice guidance for application in New Zealand. The literature review shows an increasing number of studies of RSR or related concepts in recent years, suggesting that the topic has become more popular and relevant to meeting today's transportation system challenges (notwithstanding a blip around 2021, due to the research potential provided by the Covid-19 pandemic opportunities to trial road-space reallocation).

While there were positive findings at the local level, the research did not establish substantive impacts and effectiveness of road-space reallocation on *wider* network VKT, largely due to the paucity of available evidence to date. However, the following **recommendations** are made to improve on this research, and to potentially generate more substantial evidence in future:

- It would be useful over time to further build up the collection of case studies presented here, with more examples (from New Zealand and overseas) to improve the value of the database.
- Future RSR projects in New Zealand should attempt to capture a wide range of transport metrics before and after their implementation (including short-term and long-term changes), ideally covering a reasonably large network around the treated site and with a similar control site measured for comparison.
- It would also be useful to revisit some case studies that currently have only relatively immediate (short-term) results captured, to assess what the *long-term* changes in travel patterns are.
- Further investigation should be made of the transferability and applicability of the European MORE road space allocation web-based tool sets for option development and appraisal across its socio-political, technical, economic and multi-criteria analysis modules.

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AUTHOR CONTRIBUTION STATEMENT

All three authors contributed to the original NZTA research project and resulting report and database. Glen Koorey prepared and revised this draft conference paper, which Megan Gregory and John Lieswyn reviewed.

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