Strategic intent and the management of infrastructure systems

Carron Blom

Lucy Cavendish College

Centre for Sustainable Development

Department of Engineering

University of Cambridge

This dissertation is submitted for the degree of Doctor of Philosophy

July 2017

HUMAN FELICITY IS PRODUCED NOT AS MUCH BY GREAT PIECES OF GOOD FORTUNE THAT SELDOM HAPPEN AS BY THE LITTLE ADVANTAGES THAT OCCUR EVERYDAY

Benjamin Franklin

SUMMARY

Infrastructure is presenting significant national and global challenges. Whilst often seen as performing well, infrastructure tends to do so against only limited terms of reference and short-term objectives. Given that the world is facing a new infrastructure bill of some £40T, improving the benefits delivered by existing infrastructure is vitally important (USD$57T; Dobbs et al., 2013).

This thesis investigates strategic intent and the management of infrastructure systems; how factors such as organisational structure and business practice affect outcomes and the ways in which those *systems* — not projects — are managed. To date, performance has largely been approached from the perspective of project investment and/or delivery, or the assessment of latent failures arising from specific shocks or disruptive events (e.g. natural disaster, infrastructure failures, climate change). By contrast, the delivery of system-level services and outcomes across the infrastructure system has been rarely examined. This is where infrastructure forms an enduring system of services, assets, projects, and networks each at different stages of their lifecycle, and affecting one another as they develop, then age. Yet system performance, which also includes societal, organisational, administrative and technical factors, is arguably the level relevant to, and the reality of, day-to-day public infrastructure management.

This research firstly investigated industry perceptions in order to test and confirm the problem: the nub of which was the inability to fully deliver appropriate and relevant infrastructure outcomes over the long term. Three detailed studies then explored the *reasons* for this problem through different lenses; thereby providing an evidence-base for a range of issues that are shared by the wider infrastructure industry. The results:

- provide a range of novel insights that are applicable to industry at several levels;
- highlight a range of complex, interrelated features of the management of infrastructure systems, which do not fulfil, or align with strategic intent; and
- point to a range of implications for long-term outcomes.

In confirming its hypothesis that "*the strategic intent and the day-to-day management of infrastructure systems are often misaligned, with negative consequences for achieving the desired long-term infrastructure system outcomes*", this research has increased our understanding of the ways in which that misalignment occurs, and the consequences that result. It found those consequences were material, and frequently not visible within the sub-system accountable for the delivery of those outcomes.

That public infrastructure exists, not in its own right, but to be of benefit to society, is a central theme drawn from the definition of infrastructure itself. This research shows that it is not enough to be focused on technical outcomes. Infrastructure needs to move beyond how society interacts with an asset, to the outcomes that reflect the needs, beliefs, and choices of society as well as its ability to respond to change (aptitude).

Although the research has confirmed its hypothesis and three supporting propositions, the research does not purport to offer '*the* solution'. Single solutions do not exist to address the challenges facing a complex adaptive system such as infrastructure. But the research *does* offer several system-oriented sense-making models at both the detailed and system-level. This includes the probing methodology by way of a diagnostic roadmap. These models aim to assist practitioners in managing the transition of projects, assets, and services into a wider infrastructure system, their potential, and in (re)orienting the organisation to the dynamic nature of the system and its societal imperative.

ACKNOWLEDGEMENTS

I am grateful to all those who willingly and voluntarily gave their views and time to inform this research. This includes those from industry, the two study organisations (Auckland Transport and the New Zealand Transport Agency), and all the community volunteers who participated in workshops and the survey. This research hinged on obtaining unfettered feedback on organisational and industry performance, and I am humbled by the frankness of the openness afforded to me. I also wish to thank those from within the University and industry who leant an open mind to the development of the research approach, as well as much needed encouragement throughout the rest of my studies.

Although there are too many names to mention everyone, special thanks go to Peter Clark, Andy Finch, Peter King, Dr. Ron McDowall, Dr. Miles Parker, Dr. Annette Mahon, Dr. Kelvin Walls, and of course to my supervisor Professor Peter Guthrie. Thank you Peter for all your wisdom and support. Thank you too, to everyone who stood by my side, and believed in me when times were tough; none more than my husband Anthony and son Simon, without whom this would not have been possible.

Financial support for this research has generously been given by Dr. R. McDowall, Cambridge University Engineering Department (Ford of Britain Trust), and:

CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

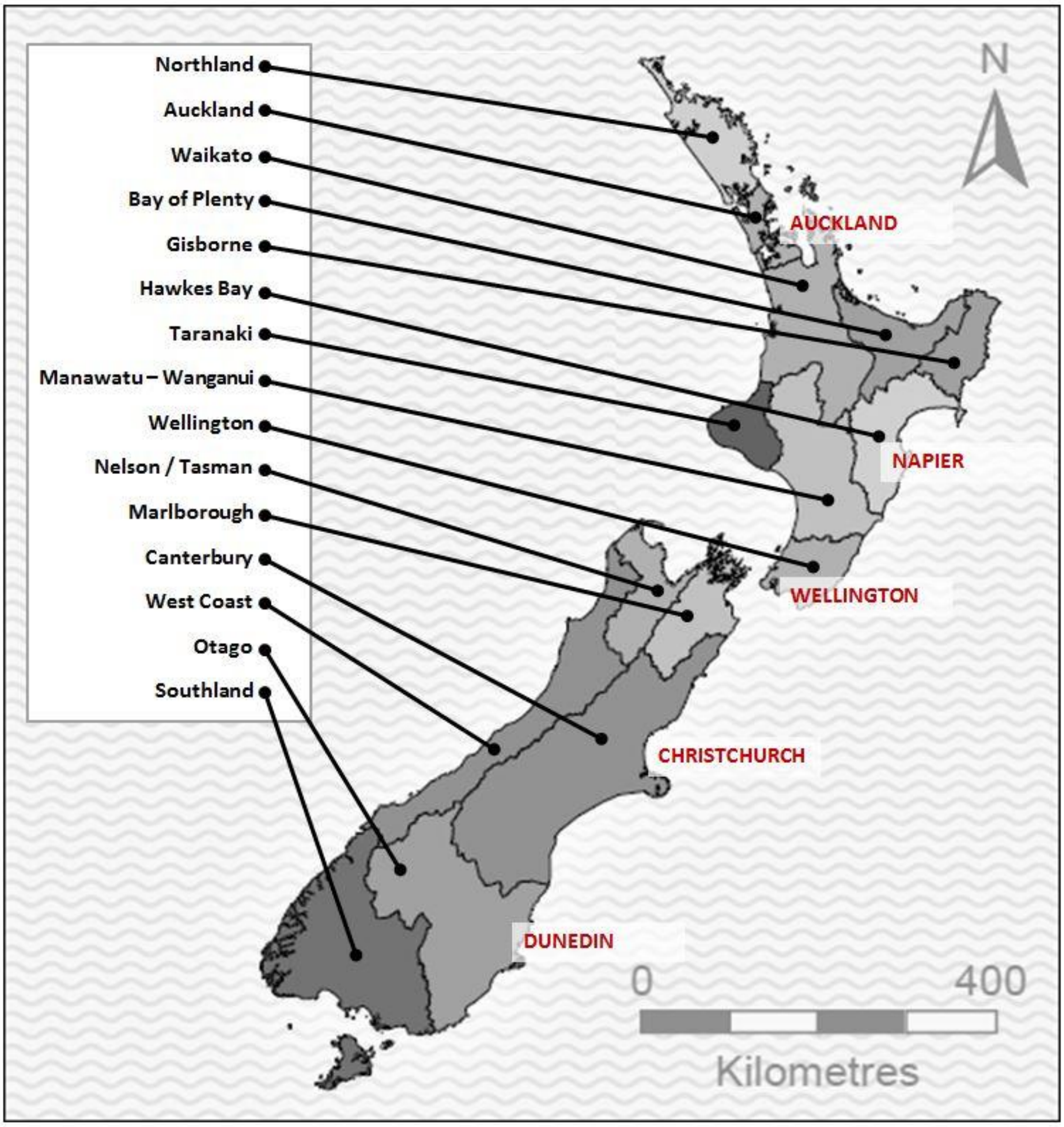
AMETI	Auckland-Manukau Eastern Transport Initiative.
AMP	Asset Management Plan.
AT	Auckland Transport.
BCR	Benefit–cost ratio.
BT	Business technology.
CAPEX	Capital expenditure or the costs of building new infrastructure. Audit New Zealand (2010, p. 76) uses the following definition from the Royal Institution of Chartered Surveyors "*one-off expenditure on major items which have a life of longer than one year (e.g. land and property)* [...] *with current expenditure implications*". CAPEX can include rebuilding older infrastructure if the cost of the 'renewal' exceeds budgetary thresholds (defined by context).
Consequential OPEX (cOPEX)	New maintenance and operational expenditure (OPEX) arising from capital development.
EU	European Union.
IPENZ	Institution of Professional Engineers New Zealand.
IRI	International roughness index.
IT	Information technology
ITP	Integrated Transport Programme.
KPI	Key performance indicator.

Latent factors	Latent failures derive from factors which may not in themselves result in failure, which may take time to become apparent, or which may lie dormant until combining with other factors or circumstances (Reason, 1990).
LGA	Local Government Act, 2002.
$LGA_{(AC)}$	Local Government (Auckland Council) Act, 2009.
LoS	Level(s) of service.
LTMA	Land Transport Management Act, 2003.
MoW	New Zealand Ministry of Works and Development.
NAMS	National Asset Management Support.
NZ	New Zealand.
NZTA	New Zealand Transport Agency.
O&M	Operations and maintenance.
OPEX	Operational expenditure or operating costs. Audit New Zealand (2010, p. 78) advises that OPEX is revenue spending, and uses the definition within the International Infrastructure Management Manual, which states that OPEX "*include*[s] *costs for operations personnel, materials, fuel, chemicals and energy consumption etc.*"
RLTP	Regional Land Transport Programme.
RMA	Resource Management Act, 1991.
RPTP	Regional Public Transport Plan.
SOI	Statement of Intent
STE	Smooth travel exposure.
System	*A system is a network of interdependent components that work together to try and accomplish the aim of the system*. (Deming in Holmgren, 2005, p. 17).

TDM	Travel demand management.
UK	United Kingdom.

LOCALITY GUIDE

A guide to the New Zealand regions (black) and cities (red) referred to within this research:



Source: Modified from Statistics New Zealand (2014)

FOREWORD

I have spent 25 years integrating the principles of sustainability into a diverse range of infrastructure projects and strategies in New Zealand, Australia, and the Pacific. Over that time, I observed that, even where the projects involved innovative solutions to address whole-of-life matters, it was often difficult, subsequently, to sustain — or even deliver — all the intended outcomes once the project was handed over for routine operation. At first, I treated these problems simply as challenges to be overcome. However, it became clear to me that not only were there issues with the integration of project assets and services into the wider physical system, operational practices often did not align with, and support, some outcomes. This was particularly evident where infrastructure:

- served several functions: For example, a constructed wetland delivering stormwater treatment, and cultural, amenity, and ecological benefits; and/or
- could not be managed using existing asset management tools: For example the inability of conventional (linear) road asset management systems to capture non-linear assets (e.g. public transport facilities), or non-standard materials/solutions (e.g. constructed wetlands). Issues were exacerbated where there was a reliance on, and/or assumption that those same systems had captured all ongoing operational requirements.

These were not the only examples, and issues that had the potential to erode long-term outcomes — or had already done so — were encountered at all stages (strategic, project, operational).

These problems are not unique to my experience. For example:

- M. Brown, Clarkson, Barton, and Joshi (2013) describe ‘follow-through’ issues with ecological compensation practice. New Zealand infrastructure development is often subject to conditions, which may require ecological compensation. Aside from being a matter of non-compliance, failure to follow-through on conditions can erode the outcome(s) upon which that infrastructure was predicated.

- IPENZ (2010) identified issues in areas of infrastructure performance reporting, and questioned whether society was actually getting the levels of service being reported.

As will be seen, industry interviews completed as part of this research provided yet more examples of eroded outcomes: of water treatment plants becoming ineffectual because investment and design decisions are not well understood; of perverse outcomes arising from coupling with personal and/or project or organisational performance measures, and of ***infrastructure being managed around technical performance rather than customer need.***

Such problems do not relate to whether project-level initiatives were being delivered across project stages. Project-level matters, such as the follow-through of actions arising from environmental effects assessments, have already been the subject of other investigations (e.g. Arts, Caldwell, & Morrison-Saunders, 2001), and is an area that I worked on some time ago (e.g. Blom, 1997, 2000). Rather, the point is that even if questions of project delivery are fully addressed across all project stages prior to handover, there remains a wider systemic problem. This relates to the operational ability to deliver intended outcomes, not just of the project, but of the underpinning systemic strategic intent that firstly defined that project. What is required is Systems Thinking for *systems*, not projects.

Whilst this is not solely an engineering, operational, or performance issue, this is, nonetheless, a problem for engineers. This is because engineers are predominantly responsible for the delivery, management, and operation of public infrastructure and the control of the wider organisational framework. So, while infrastructure rarely fails catastrophically, and may perform well in the short term or from a certain perspective, engineers need to address these problems of outcome delivery, which are insidious, complex, not widely articulated, and furthermore, less researched. Without systemic research we cannot be sure of whether the problems are material, and are left with unconnected anecdotes that are of limited value in improving the delivery of infrastructure outcomes.

Before going further, two fundamental matters are brought to the reader's attention. Both are discussed again within the thesis, and both shape how the research has been, and needs to be, approached:

- The first is a reminder that infrastructure is "*the basic physical and organisational structures and facilities (e.g. buildings, roads, power supplies) needed* ***for the operation of a society or enterprise***" ("Oxford English Dictionary (online version)," 2014; emphasis added). Notably, assets in themselves are not sufficient for the delivery of outcomes, and so underline the importance of the service(s) delivered by built infrastructure.
- The second is that when considered in its context, infrastructure exists both as a system itself, and within a wider system (Hall, Henriques, Hickford, & Nicholls, 2013). Here, it comprises all the services, assets, projects, and networks with which it co-exists and interacts — all at different stages of their lifecycles — dynamically affecting one another as they develop, then age.

In short, conventional, linear thinking is inadequate to deliver intended long-term infrastructure outcomes and a new paradigm is required; one that is both outwardly focused and system oriented. We need a different 'mental model' from the project- and asset-based conventions that dominate infrastructure practice at this time (e.g. Edkins & Zerjav, 2014; Lenfle & Loch, 2015), and must address the question as to whether current infrastructure practice is capable of supporting system-level strategic intent.

PART I: CONTEXT

Are the strategic intent and the day-to-day management of infrastructure systems misaligned, and does this have negative consequences for achieving the desired long-term infrastructure system outcomes?	
Part I: Context	**Is there misalignment, and how is this recognised as a problem within the wider infrastructure industry? What are the stories?**
Part II: Detailed studies	How is the misalignment being generated (what are the reasons for the misalignment)?
Part III: Synthesis	What characterises this misalignment or 'gap'? Given this, what are the implications, if any, for infrastructure administration and long-term infrastructure outcomes?

1 BACKGROUND

This thesis investigates the relationship between the strategic intent and the management of infrastructure systems. Much has been written from a management perspective about the challenges in implementing strategy and aligning day-to-day management with strategic intent.[1] Attention has also been given to the matter of project selection and the factors that promulgate poor project outcomes.[2] Yet infrastructure operational matters have received relatively little attention. Whilst operational infrastructure does not often fail catastrophically during its design life, it also does not appear to be performing as well as it could be.[3] It is this less obvious underperformance that is the problem that interests this research.

For infrastructure associated with the public sector (the focus here), under-performance has been highlighted by the metric-driven approach of ‘New Public Management’ (Hartley, Donaldson, Skelcher, & Wallace, 2008). Performance has otherwise been addressed:

- in relation to the latent failures arising from specific disruptive events (e.g. natural disaster, infrastructure failures, climate change); or
- from a project- or artefact-oriented perspective (e.g. through network modelling, asset management, or project management and delivery frameworks).

However, a distinct ‘project’ exists for only a relatively short period before being embedded within the wider system and dispersed across operational functions and

[1] e.g. Ford and Schellenberg (1982), Kaplan and Norton (2001, 2008); Kim and Mauborgne (2005); Loch and Tapper (2002); Prahalad and Gary Hamel (2003), to name but a few.

[2] e.g. the corpus of work by Flyvbjerg, the OMEGA Centre, amongst many others.

[3] e.g. Dobbs et al. (2013); IPENZ (2010).

processes. Instead, infrastructure is an enduring system that comprises multiple interacting services, assets, projects, and networks — all at different stages of their lifecycles — dynamically affecting one another as they develop, then age.

The challenge, then, is integrating individual projects, assets, and service initiatives, into the existing system. This is so that their impacts, benefits, and contribution to the whole system can be recognised, understood, and managed. In other words, Systems Thinking for *systems*, not projects. Whilst this should arguably be the reality of day-to-day public infrastructure management, this has rarely been examined from the perspective of delivering services across the system.

This research, therefore, firstly investigates the literature and the views of infrastructure practitioners. This is to ascertain whether there is a (perceived) misalignment between the strategic intent (intended outcomes) and the way in which infrastructure systems are managed, the outcomes that result, and how this is recognised, and described. After this broad inquiry, three different cases are studied to explore the emergent issues in depth and from three different perspectives, in order to gain qualitative insights into effective infrastructure practice.

This is novel given the likes of Hartley et al. (2008); Jackson (2009a); Jowitt and Milke (2013), are of the view that whole-of-systems working is still emergent in operational research and is even less advanced in the areas of public service and thence public infrastructure administration. The research also offers several system-oriented sense-making models at both the detailed and system level. The aim is to assist practitioners in managing the transition of projects, assets, and services into a wider, dynamic, infrastructure system that is focused on externally oriented service outcomes.

The case/field focus on understanding is preferable for new theory development in operations management **[…]** ***because eventually, the explanation of quantitative findings and the construction of theory based on those findings will ultimately have to be based on qualitative understanding.***

Meredith (1998, p. 453)

1.1 Infrastructure context and literature

What is infrastructure?

Infrastructure is critical to many aspects of society and the quality of life in our communities (e.g. Armitt, 2013; Dobbs et al., 2013; New Zealand Government, 2011b; OECD, 2012). Often simply described by its fixed, physical assets or networks, these are typically long-lived structures, individual assets such as bridges or buildings, often having a design life of 50-100 years.[4]

However, the value of these assets lies not in the structures *per se*, but in their societal outcomes, as infrastructure is, by its very definition ("Oxford English Dictionary (online version)," 2014; emphasis added):

> *The basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies)* ***needed for the operation of a society or enterprise.***

Public infrastructure is that used by or within the public realm, and in New Zealand (the focus of the later detailed studies), this is generally in some form of public ownership (New Zealand Government, 2011b). It is acknowledged that, elsewhere, this might not always be the case (e.g. parts of the United Kingdom (UK) water sector). However, the focus here is upon the underlying infrastructure (engineering management) practice. This distinguishes between the business acumen expected within New Public Management (discussed next) and infrastructure organisations that exist as a commercial enterprise.

---

[4] As a network or a system, infrastructure can endure for centuries (the proverbial ‘grandfather’s axe’ or ‘Theseus’s ship’). Roman roads, which often describe modern transport routes across Europe, are an example of this (Carreras & De Soto, 2013). Infrastructure is therefore an ‘evolutionary system’ (Atkinson & Moffat, 2005; de Wit & Meyer, 2010; Green, 1994; Star, 1999; van der Lei, Herder, & Wijnia, 2012), complete with the added complexity that comes with social, functional, and individual perspective and perception.

What are some of the key challenges facing infrastructure administration?

It is both the critical nature of infrastructure and its interdependencies that underline the significance of the global challenges now being presented. These include the following issues:[5]

- much 'new world' or post-war infrastructure is simultaneously approaching the end of its design life;
- infrastructure is often poorly performing, or inadequate for current and future needs; and
- natural disasters have underlined the importance of infrastructure resilience.

Yet the catastrophic failure of infrastructure is relatively rare, and indeed infrastructure may be perceived or reported as performing relatively well in many areas (e.g. New Zealand Government, 2011b). However, this may only be the case when considered against a limited set of performance measures and frequently short-term considerations (M. Brown et al., 2013; Controller and Auditor-General, 2014b; Fenner & Ainger, 2014). Furthermore, and irrespective of any reported good performance, there is also an identified need for ongoing improvement (Controller and Auditor-General, 2014b; New Zealand Government, 2011b).

Unsurprisingly, there is a growing focus on the outcomes being delivered, particularly by existing infrastructure. This follows the development of 'New Public Management' in the public sector, which emphasises business-like performance management and stakeholder collaboration (Asquith, 2016; Dunleavy & Hood, 1994; Hendriks & Tops, 1999, 2003; Hood, 1991; Lowndes, 1997). However, infrastructure-related literature in this area appears to be sparse. Almklov and Antonsen (2014, p. 1) provide one of the few examples to consider the implications of New Public Management upon infrastructure practice. Significantly, they found that it "*renders essential aspects of operational work invisible — including practices that are known to be of importance for reliability*", particularly operational co-

---

[5] Dobbs et al. (2013); Fenner and Ainger (2014); Guthrie and Konaris (2012); Hall et al. (2013); OECD (2012); and OMEGA Centre (2012).

ordination and the retention of operational history. In this regard, Almklov and Antonsen (2014, p. 1) observe that operational work has no clear beginning or end, and that this may be "*hard to prescribe, describe, and control*". They argue that this is at odds with the New Public Management model, and that there is very little research into the effects of New Public Management upon the practice of operating critical infrastructure.

How has infrastructure research approached these challenges?

Attention has been given to improving outcomes through *ex ante* project selection or investment processes (e.g. Flyvbjerg, 2009; Flyvbjerg, Bruzelius, & Rothengatter, 2003). However, whilst of vital importance, overall performance requires more than the delivery of a programme of works. Crucially:

- infrastructure governance systems have typically remained unchanged despite their ability to effect positive change (Dobbs et al., 2013); and
- feedback within infrastructure management practice is poor (Busby, 1998), and any differences between planned and actual project performance are frequently "*explained away as an isolated instance of unfortunate circumstance*" (Flyvbjerg, Skamris Holm, & Buhl, 2003, p. 72).

In this context, Edkins and Zerjav (2014, pp. 2-3) argue that the asset- and service--based typologies need to be broadened to construct "*a novel concept of infrastructure and the management of its interdependencies that moves beyond the domain of engineering artefacts and includes interactions between actors, organizations and institutions*".

Research on latent failures[6] can provide one form of engineering and infrastructure feedback. The effect of latent failure has been researched in the area of natural disasters (Desouza & Flanery, 2013), catastrophic failure of infrastructure (e.g. Matthew Bolton, Bass, & Siminiceanu, 2008; Reason, 1990), or emergent events such as climate change (Crabbé & Robin, 2006). Whilst arguably germane to infrastructure operations, latent failure analysis is seeking either specific root

[6] e.g. Reason (1990).

causes or outcomes relative to a specific event (e.g. Goodman & Ramanujam, 2012; Reason, 1995).[7]

However, there are few published studies that explore the shortcomings of ‘business-as-usual’ operations within the public infrastructure space, and more particularly addressing such issues at a system level. This includes research both into failure of the system as well as the positive flip side to this, system ‘fitness’ (to extrapolate Flyvbjerg (2009)). Work by the World Bank describe “*big holes in the big picture*” (Estache & Fay, 2010, p. 3). As Schön (1991, p. 9) has observed:

> *A series of announced national crises — the deteriorating cities, poverty, the pollution of the environment, the shortage of energy, seemed to have roots in the very practices of science, technology, and public policy that were being called upon to alleviate them.*

Of the research that does exist in this area, most examines the problem from within Classical Optimisation Theory (e.g. Durango-Cohen, 2007). The nearest relevant research is that from the healthcare sector where the research is starting to explore whole-of-system working (see Section 1.2.2).

Is there a public infrastructure research need?

Much of the current literature about built infrastructure examines issues through a project-centric lens rather than that of the system. This presupposes a conventional asset lifecycle of: plan–build–maintain–dispose (Figure 1.1), and examines the issues with the implicit presumption of delivering more projects, then optimising the maintenance and renewal of the hard assets.[8] Accordingly, much of the existing literature is essentially focused on optimising each of the tasks or stages within the lifecycle, with a particular emphasis on project delivery and asset management.

[7] The limitations of this approach being identified as a problem for the public service sector (Hartley et al., 2008).

[8] Similar linear ‘systems models’ may be found in manufacturing and management, such as that promulgated by Deeming (in Seddon, 2008).

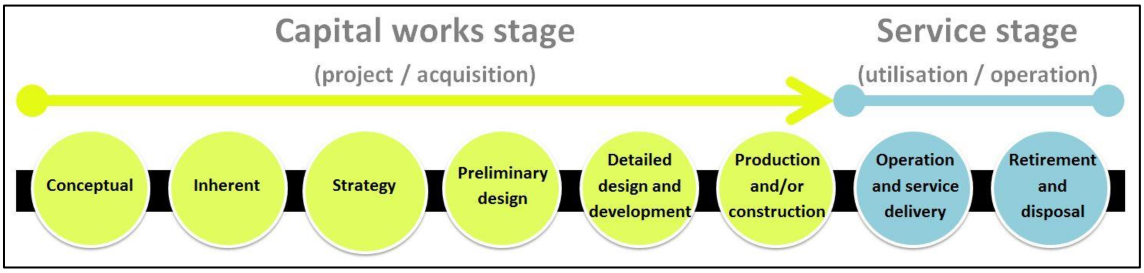


Figure 1.1: Conventional infrastructure lifecycle

Source: Synthesised from Guthrie and Konaris (2012); Lenferink, Tillema, and Arts (2008); van der Lei et al. (2012)[9]

This raises three points:

- Project delivery is a bounded system that is generally subject to controlled or managed changes in parameters within its boundaries. Whilst project- and system-level matters are not mutually exclusive, they should not be assumed to be one and the same.
- Whilst infrastructure systems are dynamic, for those infrastructure types with the ongoing delivery of assets/projects/programmes, that state of flux and change is exacerbated. This is because, excluding most renewals, capital works or projects are ultimately designed to develop and change both the assets and function of the system.
- The lifecycle (and its key stages of strategy/planning, capital works, and operations/maintenance) is more than just a theoretical model, it can also reflect/dictate organisational structures, silos, and processes. It is notable that many organisations within the physical/built infrastructure sectors (i.e. roads, rail, energy, waters) are implicitly arranged to reflect this lifecycle.[10,11]

---

[9] Whilst often shown in circular form, the 'lifecycle' remains ultimately project-oriented, and linear. Note the simplification of the operational phase and in particular the absence of any renewal and/or repurposing processes.

[10] P. Higgs, (New Zealand President, Institute of Public Works Engineering Australasia), *pers. comm*., 22 August 2016. Also see Chapter 3.

[11] This particularly differentiates built infrastructure sectors from other public infrastructure such as health services and policing (e.g. Seddon, 2008).

So, whilst there is an extensive body of literature aimed at improving (optimising) aspects of infrastructure management (e.g. project[12] and asset management, strategy development, network function, benefit management, risk management), the reality is that this is not addressing system-level issues. This reality is reflected in a number of frustrated comments within the literature, for example:

- *We often have quite messy, poorly structured situations where objectives are not clear, where different constituencies have conflicting aims and where the way forward requires vision and leadership as well as hard analysis and design.* (Morris, in Winter, Smith, Morris, & Cicmil, 2006, p. 645)
- *Whilst the traditional engineering research methods are valuable to study the physical artefacts of infrastructure, such methods clearly have limitations in addressing the complexities that arise from social, financial, power, and other kinds of relations between different human actors and organizations that enact the web of infrastructure phenomena.* (Edkins & Zerjav, 2014, p. 13)
- *Such problems can no longer be solved by the application of still more 'engineering fixes' nor are they amenable to the conventional remedies of human factors specialists* [...] *These* [...] *depend upon acquiring a better understanding of the breakdown of complex socio-technical systems, and the development of new techniques of risk assessment.* (Reason, 1990, p. 28)

There is, then, a need to understand if, where, and how a breakdown in the business-as-usual management of infrastructure is occurring at the system level, and how this might then affect strategic decision-making or infrastructure governance.

1.2 Wider literature

Public service failure and turnaround are issues of pressing practical concern in most nations, yet theoretical and empirical research in this field is sparse.

Boyne in Hartley et al. (2008, p. 249)

[12] Including literature that canvasses the ability to deliver project undertakings and requirements, such those relating to environmental management and compliance (e.g. Arts et al., 2001; M. Brown et al., 2013).

It transpires that the wider academic literature says relatively little directly or specifically about the relationship between the strategic intent and the management of infrastructure systems beyond that already touched upon. To echo a sentiment expressed by Loasby (1976, p. 9), who considers decision-making practice in the field of economics, "*much of the content* [of the existing literature] *consists of a variety of devices by which the trick may be done*".

As this research is concerned with understanding the system and the issues it generates (evidence), and how to approach it (sense-making) — rather than the 'how to' of public infrastructure administration (i.e. Loasby's 'trick') — an oblique approach was required. This Section, therefore, summarises literature from across a range of different disciplines with the aim of providing further context and background. Additional literature is overviewed separately throughout the document, including that which relates to the specifics of the detailed studies.

1.2.1 Operational context

Organisations do not, of course, exist in isolation.[13] Nor is the 'environment' static, or able to be controlled as a matter of convenience (Gallopin in Gunderson & Holling, 2002; Harris, 2007; Larsen-Freeman, 2013; Snowden, 2005). Nonetheless, De Geus (2002) observes that many organisations try to deal with the future by predicting it rather than asking *how* they might respond and adapt. This is a particular issue for built infrastructure, which has a convention of 'predict and provide' (Owens, 1995), is dominated by physical assets, but which needs to continually adapt and evolve. As Yorke, Walker, Holling, Gunderson, Folke, Carpenter, and Brock (in Gunderson & Holling, 2002, p. 436) opine:

> *Most of our popular and scientific ideas are based on a static view of the world and the place of humans in it* [...] *In contrast, the evolutionary*

[13] The external context and accountability is particularly critical to the administration of public infrastructure. Indeed, this is arguably one of the key reasons business and management literature only goes so far in addressing matters of public administration (Hartley and Skeltcher in Hartley et al., 2008).

> *basis of our biological insight stresses adaptation and response to changing conditions.*

Complexity Theory has emerged as a response to this environmental complexity and uncertainty (Straub, 2013; Uhl-Bien & Marion, 2008). Although the theory endures, there appears to be a resistance to/an inability to grasp or implement the principles in real terms (Ackoff, 2006; Jowitt, 2013; Jowitt & Milke, 2013; Straub, 2013). This is, at least in part, an artefact of the principles attributable to a complex system, which are distinguished from simple and complicated systems by both features and behaviours:[14]

- Self-organising, adaptive, evolutionary, learning behaviour.
- Involving the observer (playing the game, changes the game).
- The system's history is irreversible.
- Cause and effect may be spatially and/or temporally remote.
- Contradictions are treated as paradoxes rather than error.
- The level of complexity relates to the nature of system relationships rather than the number or type of component parts.
- Whilst components may be knowable, they exist as integral part of a wider, ever changing system that includes non-linear feedback-loops. A functional complex system is therefore not fully decomposable.[15]
- Component parts may be nested or hierarchic, and diverse in nature.
- Behaviour and outcomes are therefore dynamic and may not be predictable and may display (as a system or part thereof):
  - a dynamic stability (ordinary complex systems — able to respond/adapt to perturbation);
  - 'antifragile' behaviour (ability to thrive in disruptive conditions);

[14] Synthesised from (amongst others) Ackoff (1971); Folke et al. (2002); Gaziulusoy (2010); Gunderson and Holling (2002); Harris (2007); Holling (2001); Kauffman (1993); Simon (1969); Snowden (2003); Taleb (2012); Uhl-Bien, Marion, and McKelvey (2007).

[15] Simon (1969) suggests otherwise, as Loasby (1976, p. 33) explains "*decomposability matters above all because it facilitates adaptation. A completely decomposable system, as defined by Simon, would be fully adaptable to any change in its environment. The assumption of complete decomposability is an assumption of complete adaptability.*"

- emergent behaviour (emergent complex systems — continually evolving, novel systems).

Ackoff (1971) argues that a systems-approach is particularly apt for an organisation as a particular kind of system. Infrastructure, too, is at once a system and part of a system (Hall et al., 2013). In this regard, and crucially, infrastructure is also '*chaordic*', as infrastructure is continually interrelated with its environment (Olmedo, 2010, p. 77). Therefore "*since hindsight no longer leads to foresight after a shift in context, a corresponding change in management style may be called for*" (Snowden & Boone, 2007, p. 2).

In line with De Geus (2002), the focus moves to *how* a system will respond over time; the ability of the system to adapt and respond to its environment or fitness landscape (Kauffman & Johnsen, 1991), rather than to predict it.[16] This in turn introduces the concepts of long-term sustainability and resilience (Bollinger & Dijkema, 2012; Folke et al., 2002).

Because complex systems also exhibit dynamic, goal *seeking* behaviour (Ackoff, 1971), objectives must arguably shift from *outcomes* to *aptitudes*.[17] Consequently, storytelling and metaphor are oft used means of communicating complex concepts and act as organisational memes (Boal & Schultz, 2007; Murray, 1998; Snowden, 2003). These can be difficult to integrate within conventional infrastructure management processes, systems, and tools. More particularly, pinning down exactly how and when the principles have been adopted can be difficult, as there is no one solution to a complex problem or problem within a complex system. Whether this is actually problematic may have more to do with a perceived need to quantify and control outcomes, than necessarily being detrimental. This also relates to the organisation's ability to retain information and knowledge, and to learn.

[16] Infrastructure, for example, has a tradition of 'predict and provide' (Hall et al., 2013; Owens, 1995).

[17] Defined in Section 2.3.

Information and knowledge are vital to all organisations, and underpin the very meaning of a bureaucracy, which quixotically “*ensures permanence by the keeping of files and records, i.e. the 'know how' remains in the organisation and does not pass out with individuals who leave”* (Lupton, 1969, p. 9).

For example, in New Zealand, the Public Records Act (2005) requires local government to keep certain records (s17), and to lodge these with National Archives after 25 years (s21).[18] And yet, as will be seen in Chapter 5, information retention is a significant problem. Information and knowledge may also be affected by organisational boundary effects (Aldrich & Herker, 1977; Schein, 2010), or may otherwise become institutionalised or ‘canonical’ (Pidd in Hartley et al., 2008). These thereby limit an organisation’s capacity to absorb new information and to learn over time (Howlett & Morgan, 2011; Lowndes, 1997).

Another aspect to learning is the preparedness to make and learn from mistakes. This touches on a range of organisational aspects from organisational culture through to goal setting, and the implications of ‘getting it wrong’ (Harford, 2011). Ackoff (2006) identifies this as one of the key reasons organisations do not actively adopt or apply the principles of Complexity Theory.

1.2.2 Operational functioning

Systems Thinking is another area that is closely aligned with the complexity discourse. In the 1980s, social science research engaged with ‘large technical systems’ such as transportation, in which the system enables *“a multitude of specific activities to take place*" (Mayntz in Joerges & für Sozialforschung, 1998). Whilst noting that social science had tended to focus on the development and diffusion of technology and its consequences, Mayntz and Hughes (1988) observed a shift in interest to the role the systems played in society, and how such systems had developed.

[18] The interface of the archive date with the asset life of physical infrastructure, the nature of the records deemed worthy of archiving, and whether the records have been kept are all of potential interest here.

More recently, Geels (2007) investigated the transformation of the Dutch highway system in response to a stated lack of literature on the matter. Geels found that multiple levels (niche, regime, and landscape), together with the insider-outsider dynamics ascribed to Van de Poel (Ibid.), could describe the historical transformations of the study system. However, whilst touching on the nature of infrastructure as a complex system, Geels' research was ultimately concerned with past practice.

By contrast, Jackson (2009a) usefully contemplates Systems Thinking in relation to management and its place in contemporaneous operational research (terming this "*applied systems thinking*"). Whilst three strands to this are identified by Jackson, and highlight the evolution of applied system thinking, of particular relevance to this research is the commentary on a fourth tranche: described as 'recent developments'. In this, Jackson identifies two systems approaches that have been "***little discussed in the academic world*** *but are having a considerable impact on practice*" (emphasis added; Ibid., p.30):

> *'Whole Systems Working' has been influential in the field of health and social care. It is described by Hudson (2006) as the process of involving all stakeholders of a domain in a discussion about service change—all parties are encouraged to think about the way the whole service delivery system works, rather than focusing only upon their own service.*
>
> *Vanguard's system thinking combines aspects of systems thinking, lean thinking and intervention theory to deliver, it claims (Seddon, 2003):*
>
> > *A method for* [...] *achieving the ideals many managers aspire to: a learning, improving, innovative, adaptive and energized organization. It provides the means to develop a customer-driven adaptive organization.*
>
> ***This approach is getting significant take-up in the public sector, where it offers a damning critique of existing ways of doing things as well as numerous examples of a better way*** *(Seddon, 2008).*

> *Both approaches provide an object lesson in how relatively simple (though not simplistic) combinations of systems ideas can have a huge impact on improving managerial practice and the efficiency and effectiveness of organizations (Jackson et al, 2008).*

Hudson's work, which usefully synthesises a number of key Complexity Theory and Systems Thinking concepts, describes an approach for integrated working at the system level (Hudson, 2006). However, the aspiration of Hudson's definition should not be construed as prerequisite criteria or a given method for approaching complex systems (i.e. it does not automatically stand that anything less than the involvement of all stakeholders cannot be classified as a whole system approach). Indeed, Hudson (Ibid., p.21) concludes that "*a whole system approach does not offer a single technique or a new big answer"*. Supporting this, Hudson (2006) identifies four case studies,[19] each of which uses a different method. Vanguard offers yet another that targets 'command and control' regimes and seeks to optimise the administration services of local authorities with particular attention given to 'failure demand' (in Jackson, 2009a; see also Seddon, 2008; Seddon & Brand, 2008; Seddon & Caulkin, 2007).

When faced with the scale, complexity, and goal-seeking (i.e. dynamic) nature of systems such as these, Ackoff (1994) and Snowden and Boone (2007) share the view that a probing approach is required. Not only does this 'sample' the system (recalling that there is no single solution to a complex problem or problem within a complex system), it can also assist in identifying and/or assessing 'points of leverage'. These are points at which a small intervention can result in a disproportionate change or system-level outcome (e.g. Bosch, Nguyen, Maeno, & Yasui, 2013; Hudson, 2006).

---

[19] All four were in the health and social services and paid "*more than a passing conceptual nod to what a whole system approach is really about*" (Hudson, 2006, p. 18). Hudson (Ibid.) also notes that attempts to implement a whole system approach were "*few and far between*". Notwithstanding the anecdotes provided by Seddon (2008), this somewhat challenges Jackson's assertion that the approach has been influential in practice.

As Jackson (2009a) observes, this is an emerging field and it is clear that this includes not only the opportunity to contribute to the development of theory, but also methods and application. For completeness, it is noted that the call for further systems thinking/system-level research has not been curtailed or precluded by the presence of identified issues or studies within related sectors at the task, project, or change initiative level.

1.2.3 Strategy and operational alignment

Whilst Osterwalder (2004), Kaplan and Norton (1996, 2001, 2004, 2008), and McKinsey (in R. Grant, Butler, Hung, & Orr, 2011) have developed tools to assist strategy development and implementation, the gap between ‘knowing and doing’ remains an issue (e.g. Daily, Dalton, & Cannella, 2003; Ghobadian et al., 2007; G. Grant, McKnight, Uruthirapathy, & Brown, 2007). For example, Johnston and Pongatichat (2008, p. 18) have observed:

> *Distinct and definable practices (strategies and tactics) which demonstrated that, in practice* [...] *managers and staff went out of their way to avoid aligning measures with strategy, even though they had the authority and ability to change their measures and they were well aware of the strategic intentions of the organisation.*

Concluding that further work was warranted in the actual practice of strategy and management alignment, they observed several ‘coping mechanisms’ which were deployed by managers when faced with changing their practices to align with strategy:

- short-term success strategies;
- target adjustment tactics;
- blaming tactics; and
- deflecting tactics.

Should these mechanisms exist within the infrastructure industry, then this is at odds with the notion of what constitutes both infrastructure and ‘civil service’.

Commenting directly on the public sector, Boyne (in Hartley et al., 2008, p. 237) observes that the emergent emphasis on performance indicators arising from the advent of New Public Management now means "*it is easier to assess whether a service provider is failing in an absolute sense*". Boyne goes on to identify two types of public sector failure, and notes that the type of failure has a direct bearing on turnaround strategy:

- delivery of poor results (low scores on given performance indicators); and
- low legitimacy (results do not conform to stakeholder expectations).

Boyne (Ibid.) suggests the balance between the two failure modes can be linked to the strength of the institutional norms that constrain an organisation and therefore set stakeholder expectations. However, Boyne notes there is still considerable scope for further research as the focus to date has largely been upon turnaround success arising from strategies such as retrenchment, repositioning, and reorganisation.

As a subset of wider public sector practice, the ability to deliver public infrastructure that meets its strategic intent is also a prevalent theme (e.g. Controller and Auditor-General, 2010, 2014b; Dobbs et al., 2013; IPENZ, 2010). However, few studies reflect on system-level practice beyond departures from standards.

Pahl-Wostl (2002, 2007, 2009) provides many of the available examples having investigated strategic alignment as it relates to the management of natural and water resources. That work, through its exploration of collaborative learning environments and in particular the notions of single-, double-, and triple-loop learning in that context, highlights an inherent assumption of the existence of feedback-loops within the theoretical literature (Figure 1.2).[20] In so doing, it underlines the importance of both feedback, and the lack thereof, within the reality of the infrastructure lifecycle (see also Chapter 3). Of particular relevance to this research, Newig, Günther, and Pahl-Wostl (2010) further highlight a need to consider governance learning at the network (i.e. *system*) rather than actor level.

[20] It also fails to recognise that the feedback inherently results in change (i.e. that the system is therefore chaordic; Olmedo (2010)).

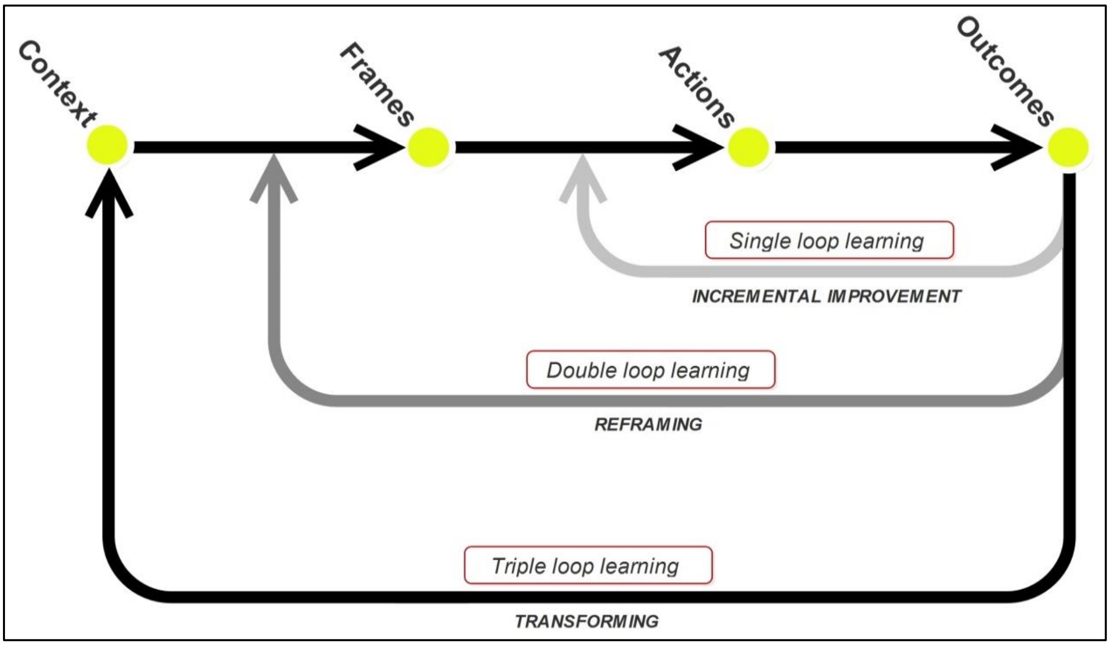


Figure 1.2: Feedback as a sequence of learning cycles

Source: Pahl-Wostl (2009)

The interrelationship and alignment of strategic intent and the operational reality of infrastructure outcomes would appear then, from the available literature, to warrant further research.

1.2.4 Decision-making

Decision-making within the public sector

Denhardt, Denhardt, and Blanc (2013) have identified the pluralistic nature of decision-making within the public sector as a consequence of access to democratic decision-making processes. Accordingly, they argue it can be difficult to identify decision centres. However, there are two facets to this: political, democratic processes; and community collaboration as promulgated through New Public Management approaches.

At the political level, Wilson (1887), argued that public administration is separate from, but informs democratic political processes. This in itself requires a clear distinction, as Wilson points out, between constitutional governance and administrative questions. Similar issues were discussed within the New Zealand local government context by the Office of the Auditor-General (Controller and Auditor-General, 2002).

In the New Zealand context, many infrastructure organisations and Council Controlled Organisations now have boards, some members of which may be political appointees. The term ‘governance’ is therefore not singular. This thesis therefore refers to the *governance* provided by a board of directors, and the *management* within the body of the organisation. Of direct relevance, one of the study organisations, Auckland Transport, has outlined its approach to governance, the political interface, and cultural responsiveness within its Statement of Intent (Auckland Transport, 2014d). This is helpful in further delineating the scope of this research.

Engineering decision-making

Decision-making is fundamental to engineering (Jowitt, 2013), and consequently there is an extensive body of literature that addresses this both implicitly and explicitly. However, much of the literature on engineering decision-making appears to have either a functional or a support focus, and although there are examples from the literature that explicitly consider the nature of engineering organisations (e.g. Busby, 1998; Dias, Subrahmanian, & Monarch, 2003), these tend to be sparse.

Bergh and Lim (2008) briefly consider engineering at the system level in their assessment of the evolution of the city. They suggest there has been a shift in focus from hardware (e.g. infrastructure), through software (e.g. quality of life, safety), to ‘orgware’ (organising capacity or the ability to deal with the hardware and the software). What still tends to be missing from the engineering literature is research into engineering decisions made at the systems level within the strategic and governance processes of public administration systems. This was also observed in the sustainability area, in which Hacking and Guthrie (2008, p. 75) identified the need for more than just comprehensiveness, and that “*strategicness*” and “*integratedness*” were also required.

Whilst commenting on literature relating to decision-making in engineering design, Simon (1972, p. 172) suggests that the paucity of material is because Classical Decision Theory concerns itself with choice among given alternatives. By contrast, he argues engineering design is about "*the discovery and elaboration of alternatives"*. Similarly, binary strategic decisions are also rarely appropriate, particularly in light of uncertainty or complexity (Courtney, Kirkland, & Viguerie, 1997). In essence, engineering decision-making includes an element of *judgement* applied to both problems *and activities* (Engineers Australia, 2012).

At a strategic or organisational level, outcomes (being the result of decision-making processes) are commonly measured against key result areas or performance indicators. Much has been written about this within management, public service, and engineering literature, including criticism of the use of such measures.[21] However, the attributes of good or sound decision-making with the merits of an outcome should not be conflated. This aligns with Higgins (2000, pp. 1217-1218), who observes: "*a decision is perceived as good when its expected value or utility of outcomes is judged to be more beneficial than the alternatives*".

Higgins (2000, p. 1226) also postulates that decisions may be good because they are morally suitable or 'fit', concluding that "*value from fit contributes to a decision being good independent of value from worth*". Furthermore, for complex systems this is less about the 'what' of the outcome, and more about the system's aptitude: its adaptive capability and capacity, resilience, and perhaps fitness.

1.3 Research relationship with the literature

Whilst there is a body of literature addressing system-level theory and practice ideals (e.g. in the form of management guidance), that same literature also tells us that there are very few actual studies that examine system diagnosis and the implementation of System Theory within Public Administration (noted by Hartley et al., 2008; Hudson, 2006; Jackson, 2009a (amongst others)). The few studies that

---

[21] e.g. Layard and Glaister (2003); NAMS (2007); Propper and Wilson (2003); Walshe, Harvey, and Jas (2010).

are available focus on the delivery of services and therefore do not penetrate the technical realm of engineering for and within Public Administration. One of the inhibiting factors for any Public Administration research appears to be the very complexity of the systems in question, and how to meaningfully engage with this; despite fifty years of operational research, Jackson (2009a), concludes this is still an emergent area. Further applied research can therefore contribute to theory development in these areas, including methods of assessment and diagnosis.

There is also an emergence of work which considers civil infrastructure as a system (or interchangeably as a system of systems). However, like the wider Public Administration research, this appears to be relatively sparse in regard to business-as-usual engineering practice as an open system in an evolving environment. Moreover, the focus remains on project-related matters and so there is a need to further explore the interface between project and system, as well as at the system level itself (and to do more than simply audit departures from normative procedure).

To recap, infrastructure systems are a 'wickedly' complex space in which there is sparse literature. This research can therefore contribute to specific challenges facing infrastructure at this time, as well as to the wider corpus on System Thinking within public infrastructure administration — not at the project level, but the application of Systems Thinking to the system — to whole-of-system working.

The term 'systems-level approach' has entered the language of the discourse **[on large scale infrastructure].** ***What remains to be done is to figure out what that actually means and then to implement it. That the major infrastructure projects of the present day are almost always controversial is not surprising, but the problems appear to be exacerbated because the basis of the decisions is unclear and the systems boundaries surrounding them are ill-defined (or not defined at all).***
Jowitt (2013, p. 291)

2 Research Overview

This thesis charts research that seeks to explore infrastructure practice from the perspective of the infrastructure system. As such, this is contemporaneous research from a 'client' perspective; the client being the infrastructure organisation as a proxy for society. The focus is, therefore, on business-as-usual operations and the context that this creates for infrastructure administration and long-term infrastructure outcomes. In particular, this research investigates the strategic intent and the management of infrastructure systems, and the implications (if any) for long-term infrastructure outcomes.

This Chapter sets out the research purpose and high-level approach, as well as key terms and other matters that help to define the research scope ('the system'). Research methods are addressed later within the document.

2.1 Purpose

My central hypothesis[22] is that:

> *The strategic intent and the day-to-day management of infrastructure systems are often misaligned, with negative consequences for achieving the desired long-term infrastructure system outcomes.*

This hypothesis is augmented by three underpinning propositions:

1. Individual infrastructure projects automatically, by their nature, become part of, are embedded in, *and change*, a complex infrastructural system (e.g. interactions, feedback, emergent properties).

[22] Developed inductively from industry experience, literature, and the preliminary research.

2. The governance and management of such systems will not be effective if focused on outputs at the level of projects, assets, or even subsystems. Governance and management needs to address the desired/intended strategic, externally-oriented outcomes and *aptitude* of the whole system. They also need to address the contributions of individual projects *and* of the day-to-day operations to that system.

3. No matter how well individual projects are designed and delivered, or strategic outcomes are initially defined, systems are dynamic. Accordingly, infrastructure administration needs to both accommodate and continually respond to this time dimension.

The challenge and level of uncertainty faced here means that the hypothesis may be considered broad. However, this is the reality for those who are charged with addressing this in practice (e.g. Bazerman, 1994; Brugnach, Dewulf, Pahl-Wostl, & Taillieu, 2008; Snowden, 2005).

2.2 Approach

Given the current levels of research in this area, it was important to firstly understand what is *actually* believed or *actually* known within the infrastructure industry, for it does not automatically stand that:

- there is a systemic problem and that this is recognised (i.e. there is a problem that exists or is recognised beyond individual examples and stories);
- there is substantive evidence of the problem;
- the problem is material or its nature is understood; and
- anything is being done about it.

This is an approach supported by Davis (1971, p. 310), who identifies a number of 'interesting non-propositions' to research:[23]

[23] Davis (1971) explores what constitutes 'interesting' research, or that which has a contribution to make. In making the point that "*non-interesting theories are those which affirm certain*

> *(1) Findings' which confirm or disconfirm hypotheses, (2) 'Clues' which indicate the way a problem can be solved, (3) 'Aesthetic Descriptions'*[24] *which refine perception, (4) 'Analogies' which render the unfamiliar in terms of the familiar, and (5) 'Models' which simplify the integration of complex relationships.*

From a practice perspective, Yankelovich (1991)[25] has usefully identified a three step approach within the policy arena that is aimed at moving communities from opinion to judgement when "*confronting system-level implications*" (Yankelovich in Constanza, 2000):[26]

- consciousness-raising or awareness;
- developing an understanding or "*working through*" the issues; and
- resolution or action.

Although notionally applicable to policy development, this is not policy research *per se*. Nevertheless, given the broader contextual parallels, the approach is considered to be applicable and relevant here.

Research structure

Yankelovich's three steps provide a simple structure for this research that can be aligned with Davis's 'interesting non-propositions', and so meld academic and practical objectives (Table 2.1). Moreover, the combined approach aligns with the

---

assumptions of their audience", Davis (1971, p. 310), excludes "*non-propositions that are also capable of evoking interest*". It is these 'interesting non-propositions' that are of relevance here.

[24] Davis (1971) does not define this term, but from Keenan (2016), it is taken to mean the experiences and stories — in this instance, of practitioners — that might describe industry perceptions around a particular issue. This is supported by Parker (2016), who argues there is the need to provide 'expert intelligence' and evidence to assist the development of policy and practice.

[25] See also Yankelovich and Friedman (2010).

[26] The prerequisite to which is given as a bridging of the gap between the "*culture of technical control*" and the public (Yankelovich in Constanza, 2000, p. 2). This has obvious parallels with the stated need to re-orient infrastructure practice to its societal imperative (Section 1.1).

views of Snowden and Boone (2007), who tell us that a probing approach is particularly appropriate to questions of complexity.

Table 2.1: Research structure

Research structure	**Research aspects**	
	Confronting system level implications *(Yankelovich, 1991)*	**Interesting research** *(Davis (1971))*
Part I: Context Is there misalignment, and how is this recognised as a problem within the wider infrastructure industry? What are the stories?	Awareness	Aesthetic description
Part II: Detailed studies How is the misalignment being generated (what are the reasons for the misalignment)?	Developing understanding	Clues/Analogies
Part III: Synthesis What characterises this misalignment or 'gap'? Given this, what are the implications, if any, for infrastructure administration and long-term infrastructure outcomes?	Resolution	Models/Findings

This structure aims to take the 'proof of thesis' beyond reliance on anecdote, thereby providing an evidence-base for both further research and action. Therefore, the structure of this research responds to both the complexity of the problem and that of the system being investigated.[27]

Document structure

This document reflects the research structure just outlined, and so is divided into three parts. The nested nature of this research is such that it does not lend itself to a simple, linear presentation of the material. This is not assisted by the very

[27] See also Chapter 4 and Figure 4.1.

different detailed studies which, whilst presenting their own results and meriting discussion in their own right, are also at once the evidence and inputs to the wider, system-level case. Accordingly, much of the material from the detailed studies has been appended, and the document structured according to the framework described within Table 2.2.

Table 2.2: Document structure

Research structure	Document chapter	Focus	Appendices
Part I: Context	**1**	Introduction, background, and literature review.	
	2	Research overview.	I. New Zealand context.
	3	Preliminary research into industry awareness, and aesthetic description of the problem.	II. Summary of interviews and workshops.[28] III. Research management.[28] IV. Lifecycle interface factors.
Part II: Detailed studies	**4**	Research need, strategy and methodology.	
	5-7	Detailed studies 1-3. Whilst these are self-contained studies, with their own introduction, methods, results, and discussion, these provide the input evidence, data, and themes which contribute to the overarching cross-case analysis.	V. AMETI overview. VI. Detailed study 1 analysis. VII. Detailed study 2 analysis. VIII. Detailed study 3 analysis. IX. Detailed study 3 questionnaire.
	8	Summary of the detailed studies.	

[28] Also applicable to the detailed studies within Part II.

Research structure	Document chapter	Focus	Appendices
Part III: Synthesis	**9**	Cross-case analysis. The results and discussion for the overarching research.	
	10	Research reflection, contribution, summary of the results and conclusions.	

2.3 Scope and limitations

2.3.1 Scope

Before moving on, there are several terms that require definition as they inform the scope of the research:

- ***Strategic intent:*** Horwath (2009, p. 26) is of the opinion that "*the "what" you're trying to achieve, whether it be a goal, an objective, or a long term vision, should never be confused with "how" you will achieve it, which is strategy.*" This thesis concerns itself, not with the "how", but rather the strategic aspirations and outcomes subsequently being sought through the tactical operation of infrastructure systems.

  Such aspirations may be expressed through visions, inspiration statements, or more formal stated goals and objectives, which provide the "*emotional and intellectual energy for the journey*" (Hamel & Prahalad, 2013, p. 141). These have been collectively referred to as the "**strategic intent**". This emphasises the focus on outcomes and benefits rather than artefacts and features. But it does not contemplate the merits of that intent, other than adopting the position that the public administration of public infrastructure is by definition, oriented to societal outcomes.

  It is also noted that although agency will be a factor in organisations (e.g. Johnston & Pongatichat, 2008), this research does not in any way offer a view on the personal *intentions* of those involved in implementing strategy.

- ***Infrastructure system:*** A complex system of artefacts, networks, services, organisations (each at different stages of their lifecycle, and affecting one another as they develop, then age), inclusive of their social/environmental context and outcomes. A system of systems. Something greater than a project.

  The focus here is on the day-to-day (i.e. tactical) infrastructure operations. Whilst the interface between the project and the system it transforms is of interest, the process of project investment and delivery — including whether the project delivers its intended outcomes — is excluded. As noted, project investment and delivery has been the focus of much research. Any issues experienced at the project level would only exacerbate those at the system level and it is important not to confuse the two, or to assume that they are one and the same.

- ***System aptitude:*** As distinct from an output or outcome. Aptitude (here) refers to the attributes of the organisational and physical system (e.g. resilience, fitness), combined with the individual/organisational/industry mind-set (culture) and orientation. These characteristics collectively define or contribute to the inherent or acquired ability and inclination of a system to respond and adapt to its evolving context. This, therefore, does not presuppose or comment on the merit of the outcome being sought, but references its goal-seeking behaviours (see Ackoff (1971); see also Section 1.2).

- ***Infrastructure governance:*** This thesis refers to the governance provided by a board of directors. Project Boards are considered in this context to be a management function. Whilst political matters will be germane, they are outside the scope of this research; as one interviewee observed "*We can still have good governance if you've got bad politics*" [PR58].

- ***Management of infrastructure systems:*** This refers to a hybrid of management, engineering, and other practice areas that exist within a public infrastructure organisation. It does not mean, but may include, management systems such as quality procedures or information management.

- ***Infrastructure administration:*** The integrated governance and management of infrastructure. Whilst this is a subset of Public Administration/Service, this does not refer to Public Administration/Service from a political or policy standpoint. Unlike a private sector organisation, infrastructure administration is externally oriented with the aim of producing 'public value' (Hartley et al., 2008).[29]

2.3.2 Limitations

This research does not consider the need for any given project, or enter into an argument on the merit of any given infrastructure solution. However, it does consider the processes that might initiate a project, and consider how system and project objectives are established and framed. Similarly, the research does not offer an opinion on how an organisation should be structured, as that is another matter.

Exogenous factors that could be subject to change have also been set aside if and where this is possible. These included matters of political influence, constitutional amendments, step changes in technology, system shocks (e.g. climate change/natural disaster),[30] and changing economic conditions (including the willingness/ability to fund). This does not mean that a static approach was taken, but rather that these would have unduly complicated matters in an already complex research space.

2.4 Sector focus and selection

As noted, what limited system-level research there is within public infrastructure has been focused on health and social services. The asset-as-service arena of the

[29] Hartley et al. (2008) define public value as that which is "*added to the public sphere*". They note that it may include social, economic, political, or environmental factors, or be "*more broadly about the quality of life*".

[30] Although, matters of preparedness, resilience, and adaptation within business-as-usual practice were considered.

physical or built infrastructure sectors, therefore, offers the opportunity to investigate a less researched area and to:

- penetrate the technical areas that underpin the broader service delivery of those systems; and
- explore the capacity of such systems to respond to the constant state of flux created by project delivery and system transformation, and how those systems sustain the benefits intended from that change.

The New Zealand infrastructure environment has been selected to research this because:

- public infrastructure remains largely in public ownership, so avoided complications arising from commercial operating models;
- there is a separation of (or at least an awareness of the need to separate) political involvement from technical and organisational governance (Asquith, 2016; Auckland Transport, 2014d; Controller and Auditor-General, 2002); and
- there was ready access to the industry.

In their call for more evidence-based theory in the realm of public service improvement, Hartley and Skeltcher (in Hartley et al., 2008, pp. 10-11) argue "*the degree of improvement cannot be assessed simply by the achievements of an individual organization or service unit, but rather is better assessed through the achievements of the whole institutional field*".

This is a considerable challenge for any systems research,[31] and, whilst conceivably this research has broader application, it was decided to use the land transportation field within New Zealand as the focus for the overarching research programme and 'unit of analysis' (Yin, 2003). The choice of this sector was in part

---

[31] The ability to meet this challenge is also addressed through the research design and methods (Chapter 4).

influenced by personal experience and knowledge of the processes across the lifecycle of projects and systems in this area.[32]

More materially, land transport was identified as a potential sentinel in the understanding of decision-making for infrastructure. This was primarily because land transport influences society through its interface with land use and economic development, and is frequently a conduit for other types of infrastructure (Carreras & De Soto, 2013; Martindale in Weber, 1958). Indeed, Martindale observes "*the street, represents first and last the greatest material problems of the city*", and quotes Henri Pirenne's declaration that "*the control of the streets means the control of the city*" (in Weber, 1958, pp. 57-58).

The land transport sector also provides an example of the transition rapidly developed infrastructure systems must now undergo to confront matters such as simultaneously ageing assets, the full realisation of maintenance costs, and ongoing growth. Furthermore, there is an identified need for further development of long-term infrastructure system performance within this sector (e.g. Controller and Auditor-General, 2014b; IPENZ, 2010). Additional information on the New Zealand context may be found within Appendix I.

[32] On several occasions during the preliminary research (Chapter 3), interviewees urged for the water sector to also be included within this research. Unlike land transport, the water sector in New Zealand is managed at the local government level, so was expected to have less consistency and central co-ordination. This was considered too "messy" for the scope of a PhD, so remains a research opportunity.

3 INDUSTRY NEED AND FOCUS

The conventional starting-point for empirical research is often theoretical knowledge taken from literature or earlier empirical findings. This contrasts with Grounded Theory which gives preference to the data, whereby theory is discovered relative to the research topic (Flick, 2002). Indeed, Flick (2002, p. 48) pointedly observes that "*research questions do not come from nowhere*", and that their origin may lie in the researcher's personal biography, their practical interests, or contextual background. Bryman and Bell (2011) and Robson (2002), concur, and Eisenhardt (1989, p. 536) notes that "*a priori specification of constructs can also help to shape the initial design of theory building research*".

Nonetheless, as this research stems from industry experience, it was important for potential bias to be recognised and tested (Thomas, 2004). Consequently, preliminary research has purposefully been undertaken to mitigate any such risk (Loasby, 1976) by investigating and testing current industry perceptions and beliefs across infrastructure sectors.

The preliminary research therefore provides pointers towards matters that would benefit from further research and where to focus the detailed studies. It investigates whether there is misalignment between the strategic intent and the day-to-day management of infrastructure systems, and captures the stories that describe how this is recognised as a problem within the wider infrastructure industry (Table 2.1). It is those same stories that are then used as part of the detailed studies to triangulate the results within the study and to reflect on the generalisability of the findings.

3.1 Preliminary research methods

Interview process

The preliminary research was based wholly around a series of semi-structured interviews (Bryman & Bell, 2011), comprising two stages:

- ***Stage 1:*** The interviews were firstly across a range of infrastructure-related organisations and sectors, focused on determining whether there is a problem, and the broad nature of that problem. A series of generalised questions probed views on infrastructure as both an artefact and a social enterprise. Appreciative Enquiry[33] was also used to identify areas that worked well (Fenner & Ainger, 2014).

  Between December 2013 and June 2014, a total of 32 New Zealand interviews were conducted along with eight in the UK and Europe. These 40 interviews covered a total of 33 different organisations. Interviewees included chairpersons/board members, chief executive officers, directors, executive management, and senior specialists.

- ***Stage 2:*** This stage sought further detail on issues and opportunities meriting closer examination. To do so, it targeted New Zealand's transportation sector. Project delivery is already well served in the literature and conventional infrastructure lifecycles are disproportionately dominated by it. For this reason an alternative system lifecycle (based on Figure 3.1) was used to focus matters towards day-to-day system-level operations.

  Between August and October 2014, a further 19 interviews were conducted within a large New Zealand municipal transportation organisation. Interviews were conducted vertically from chairperson/board-level to team leader, disciplinary specialists, and across departmental functional areas.

A summary of the stated expertise and experience covered by all 59 interviews is given within Appendix II.

[33] Learning from "*what is being done better already, rather than defining a 'problem' and solving it*" (Fenner & Ainger, 2014, p. 241).

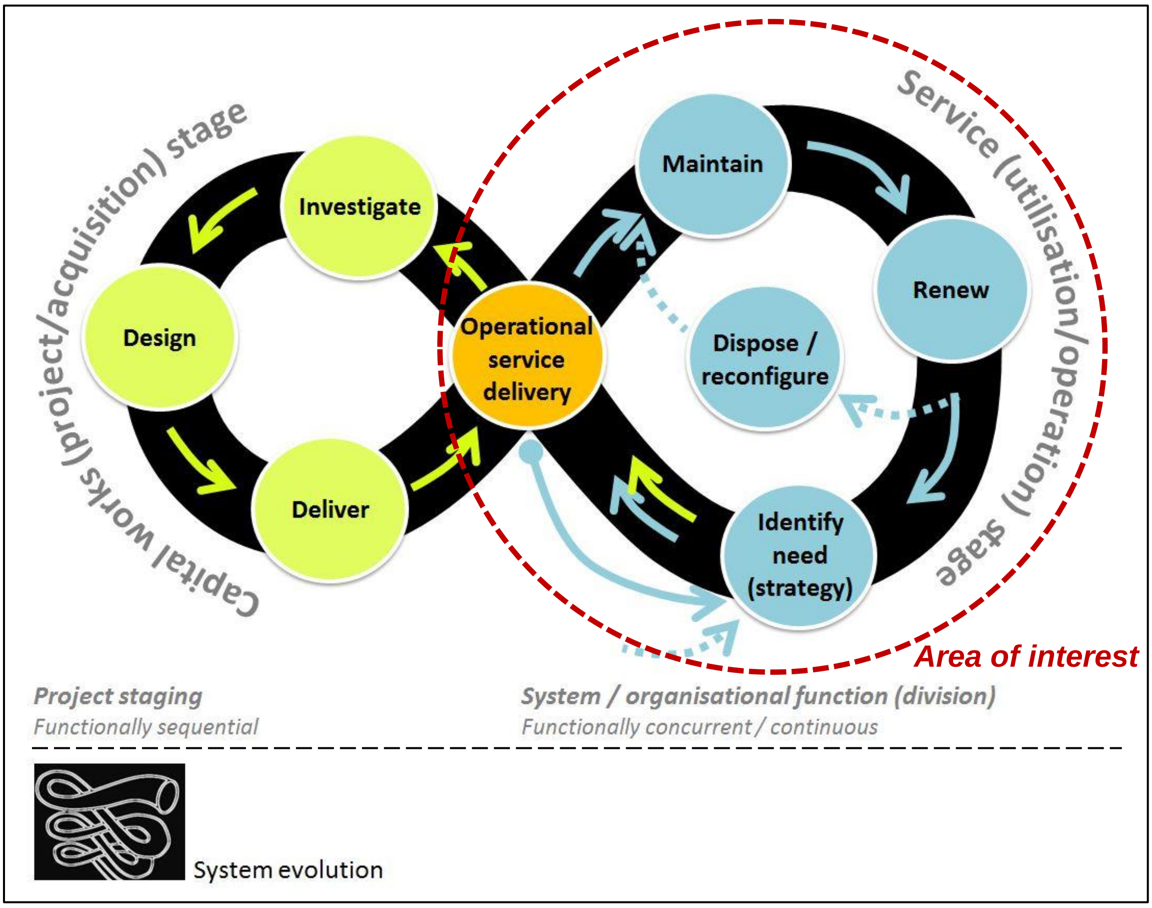


Figure 3.1: Infrastructure system lifecycle model

Source: Adapted from Blom (2014)[34]

Notes: This is first and foremost a conceptual system lifecycle, which is aimed at re-orienting infrastructure practice towards outcomes and away from project-led thinking. This is an evolutionary, sense-making model rather than an incremental improvement process (see Blom, 2014).

Project stages shown in Figure 1.1 have been merged for simplicity. This model also replaces the convention of 'Retirement and disposal' to provide for repurposing (whether at the component, asset, service, sub-system level).

Research management

Appendix III overviews the management processes adopted for this research as a whole (including ethics and the source material referencing system used

[34] From work which precedes this research.

throughout this document). The preliminary research comprised semi-structured interviews structured around an underlying framework, as follows:

- ***Stage 1:*** shared understanding of meaning/issue identification:
  - sustainability (meaning, static/dynamic attributes);
  - infrastructure (meaning, lifecycle/staging, interface with organisational structure, effects on processes and outcomes, history and context);
  - value, resilience, robustness, and adaptive capacity (meaning and relevance to infrastructure/infrastructure organisations, meaning of value in different contexts, value loss/enhancement, relationship to sustainability and long-life infrastructure);
  - system-of-systems (revisit comments at system level, what works/doesn't work and why, what is missing, what is the problem, attributes needed/key matter to be developed to address the problem);
  - for funders only (nature of involvement, criteria, industry influence, matters of interest);
  - other matters.
- ***Stage 2:*** Further clarification/transportation focus:
  - processes within 'area of interest' (Figure 3.1) important to the organisation's long term infrastructure outcomes (which and why, effectiveness, what works/doesn't work, examples, effects enabling/constraining decision-making);
  - other matters.

The framework focused upon the infrastructure lifecycle. This reflects the selection of a built infrastructure sector (transportation) both in terms of typical organisation structure and the phases through which the assets, services, and processes are managed. As such, the lifecycle provides access to many more dimensions than might be immediately apparent. Aside from excluding project delivery, there is otherwise no assumption of where or what the research should investigate in further detail.

Many of those interviewed actively sought a more general discussion. Consequently, some of the interviews were at the less structured end of the continuum (Bryman & Bell, 2011), so did not always follow 'the script' exactly.

However, the interviews generally touched upon most of the topics within the framework. It is noted that as the interviews were conducted early within the research process, the interviews did not explicitly ask the research questions as they are currently framed; those were subsequently deduced from the analysis of the responses as outlined within this Chapter.

Interviews ranged between 30-90 minutes but were generally an hour in length, and were face-to-face where possible. All interviews were transcribed before being loaded as a PDF file into qualitative research tool NVivo, which enables users to categorise or 'code' their source material (Bryman & Bell, 2011). NVivo was selected on the basis of availability, capabilities, and guidance (Ibid.).

Coding followed the Weber Protocol[35] to reduce bias (in Bryman & Bell, 2011, p. 290). Coding was typically at the paragraph level, although individual sentences were coded where appropriate (e.g. where a reference to a specific location or piece of infrastructure had been used to illustrate a point).

Both stages were processed together because views were frequently offered that transcended the focus of each stage. Furthermore, interviewee experiences often spanned infrastructure sectors, so those with transportation experience could not be arbitrarily separated. Nor could it be assumed that an answer was being given from the perspective of any one sector or organisation.

Treatment of the content

Interview material was 'divided' into manifest and latent content. Manifest content is the "*content of the item in question: what it is clearly about*", whereas latent content is the "*meanings that lie beneath the superficial indicators of content*" (Ibid., p.290). To this end:

- The manifest content was identified so data (via key words/topics) could be searched and managed for use in the subsequent detailed studies. This enabled the themes emerging from the detailed studies to be compared (i.e. triangulated) with those from across sectors and industry experience (Yin, 2003;

[35] An eight step, iterative process to reduce 'rater bias' in coding.

see also Chapter 4). As such, the use of NVivo was simply a mechanism which assisted the sorting, categorising, and subsequent use of the material so that it could be readily accessed and collated into topics, or easily searched.

Analysis of the manifest content was carried out at this point of the research so that the overarching ‘threads’ (i.e. chain of ideas/opinions) could be considered. Whilst this was of limited use at this stage of the research, as it ultimately reflects the interview questions and direction of the discussion, the primary cluster related to ‘business and technical processes’. Notably, the thread comprised lifecycle management, performance monitoring and reporting, decision-making, and general business practice. At a basic level, this provided a degree of triangulation with the latent content analysis.

- The latent content was used to answer the three questions pertaining to this stage of the research (Table 2.1):
  - is there misalignment;
  - how is this recognised as a problem; and
  - what are the stories?

  Also of interest was where, or what in the lifecycle warranted further specific investigation (e.g. strategy, projects, operations and maintenance, feedback, disposal). The assessment of the latent content was achieved by a detailed review and thematic analysis (recoding) of the primary data (see 'narrative analysis' for sense-making; Bryman & Bell, 2011).

Predefined codes were not used. Coding of the data for both manifest and latent content was therefore emergent or ‘open’ (Strauss and Corbin in Bryman & Bell, 2011). 155 nodes emerged progressively. The process was iterative and previously coded interviews were reviewed as new codes emerged. The codes were then sorted into topics and themes (Ryan & Bernard, 2003). Topics augmented the manifest content data for subsequent use in the detailed studies, whereas the themes (which are turned to next) related more directly to the research questions.

3.2 Is there a problem and what is the nature of that problem?

Whilst the available literature suggests a research gap, this does not, of course, necessarily equate to a problem in reality (Section 2.2). Indeed, some of those interviewed did feel that they (team/organisation/sector) were performing well, although acknowledging the need for ongoing improvement, for example:

> *I would say that in the last five years, people are* [...] *understanding what outcomes truly are* [...] *Therefore we are getting better at articulating in strategic terms, the outcomes we are truly trying to deliver* […which] *are generally broader than they used to be* […The] *work still to be achieved is then to be able to connect* [...] *the individual works you do, to those outcomes. To satisfy yourself that* [you] *truly are* [...] *strategy led.* [PR33][36]

However, there was a general observation amongst those interviewed that good performance was patchy, whether between sectors, organisations, projects, or over time.[37] So, even where areas of good practice were identified,[38] other individuals would have a different perspective and could point to where these were incomplete, or could improve. The interviews provided a good degree of triangulation in this regard.

The interviews also unearthed a series of belief-systems in more than one organisation, whereby one part of an organisation believed something had been addressed by another (in contrast with the subject department's own view that their

[36] This section contains quotes and references to interviews to provide examples to support the assessment. This is not a proxy for the underlying assessment.

[37] The exceptions being [PR14], [PR20], [PR38], [PR54], [PR59], [PR67-PR68] where no specific issues surfaced.

[38] e.g. recent improvements in the rate of delivery of projects to the construction market, project procurement, and asset management.

practice was rudimentary or essentially non-existent).[39] The Controller and Auditor-General (2014b) has raised similar issues.

From the perspective of those within the industry, there is a problem and the overall outcomes were suboptimal in some way. Whilst there may be many *reasons* contributing to this, the crux of the problem (issue) is **the inability to fully deliver appropriate and relevant infrastructure outcomes over the long term**:

> *I mean if you put a bunch of engineers in charge of a project, they'll do a fantastic job of delivering you a project, but* [...] *that may not actually deliver what you want to see! 'Cos they're focused on design and implementation and doing and all of that good stuff —mission critical — but if you haven't got your problem definition and solutions sorted out in the first place, you end up with the sorts of problems that* [...] *we've just had a long discussion on!* [PR18]

In describing the overarching problem, many interviewees[40] also pointed to a misalignment between the intended strategic, or system-level, outcomes (or benefits) and the delivery, or management of those outcomes over the longer term. What was also clear was that there was no real understanding of the scale and scope of that misalignment, nor the significance of any implications, because system-level outcomes were not being given sufficient attention:

> *There definitely* [is a] *loss of value there* [in operations and maintenance (O&M)…]*. I think that* [things like community aspirations] *probably gets lost quicker because of the relationships with* [...] *whoever the community or stakeholder is, tends to be quite strong in the design phase, but gets lost quite quickly in the O&M phase. Even within the client they're different people usually.* [PR25]

[39] e.g. [PR 16], [PR19], [PR21], [PR 25-PR26], [PR32-PR33], [PR37], [PR39], [PR44], [PR47], [PR53-PR54], [PR56].

[40] In addition to those quoted below, this surfaced in the following interviews: [PR13], [PR15-PR16], [PR18-PR19], [PR21-PR22], [PR24], [PR26], [PR28-PR33], [PR35], [PR37], [PR39-PR40], [PR42-PR44], [PR46-PR47], [PR70].

> *Well I think in* [...] *a long-term analysis point of view there're some learnings you get* [...] *at the completion of the project. So it's the success of the* project*. But when you have the longer-term* [...] *evaluation, it's the success of the original intent or the intention that led to the project being one of the reasons why* [...] *the money was spent* [...] *And I think we don't do that enough* [...] *We don't look at whether the assumptions we made —and* [...] *it's probably because the environment's always changing and* [...] *well, one, I think we don't think about it and two* [...] *if I think about it, we say 'oh well, there's so many variables, and there's gonna be ups and downs and overall* [...] *somehow and somewhere* [...] *it would balance out'.* [PR27]

> *I don't think we do well at going back to the* [...] *three years review and say 'well, why didn't that play out?', and understand why* [...] *and* [...] *informing decisions going forward from that point* [...] *You just keep stacking more and more jobs on to the* [...] *schedule of work to be done, 'cos we want to develop more areas, and we don't* [...] *actually draw value out of the decisions we've made in the past. We* [...] *don't go back and test the outcomes* [...] *that we thought we were going to do from* [...] *the first decision process* [...] *I can see nowhere where we can sit down and do a real benefit evaluation at the end of the process.* [PR64]

From the perspective of those being served by infrastructure, the problem is a significant one. For example, New Zealand local government, where infrastructure-related services are a vital part of council function, has recently surveyed 2,400 residents and 594 businesses (Local Government New Zealand, 2015). That survey found that whilst the results might generally be 'good' by being indirectly comparable to countries such as Australia and the UK, this was of "*little comfort*". This was because respondents to the New Zealand survey only rated local government performance at 28 out of 100 (Ibid.). IPENZ (2010) has reported similarly poor customer feedback in other infrastructure sectors.

So, whilst there is no suggestion of catastrophic failure, this points to a more insidious issue of omission and unrealised potential; of society working around its infrastructure. As Hellström (2007, p. 417) observes:

> *Disruption does not come about through expansion of a system, but rather because incremental change may embed design flaws gradually deeper into a system, where ad hoc solutions to improve workability hide problems under increasingly thick layers of technological 'improvements', yet do not eliminate them.*

Ironically, whilst the primary issue might be simple to articulate, it is paradoxically complex. In this vein, four key problem dimensions emerged from the interviews:

- **Needs**: What is delivered and how it is delivered.
- **Precepts**: What customers believe or expect to be delivered.
- **Choices**: Whether the choices are appropriate and purposeful, and that compromises have been understood.
- **Aptitudes**: Whether there is the ability to change both reactively and proactively.

Much of the infrastructure literature currently focuses on 'doing the right projects right'. Yet the emergent dimensions show that there is more to the problem space than addressing 'need' in any simple sense. Furthermore, whilst there was a shared awareness of the importance of improving long-term infrastructure outcomes at senior levels, the management of system-level benefits also seemed to be the 'elephant in the room'. Because a piece of infrastructure hasn't fallen down and may 'only' be perceived as (i.e. not 'actually') a problem, does not mean that the problem is neither real nor significant as there are more dimensions to the issue than indicated by the hard infrastructure assets alone. Infrastructure customers often have little or no choice in where they go for infrastructure services, and may not be heard over technical and funding considerations. These are the matters of stakeholder salience and legitimacy[41] developed by Mitchell et al. (1997).

[41] "*Who and to what managers actually pay attention*" (Mitchell, Agle, & Wood, 1997); similarly, Ramsden and Spoonley (1993) ask who defines what is important.

And yet, as the industry proverb goes, there is no point building good quality concrete life jackets.

3.3 Generalisability

Interviewees were asked whether the issues they raised related solely to a particular instance or context described (circumstances, organisation), and whether this was a country-specific issue. Many of those interviewed had worked in more than one country within a variety of different contexts, and had experienced common themes across these.[42] Interviewees were therefore well placed to affirm the generic nature of the examples and the issues raised. Their feedback suggests that it is not 'just' poor organisational, sector, or country-specific practice, and that the issues are worthy of being explored further. Comments particularly emphasised differences between theory and practice, and how the issues can stem from an expectation or perception that practice occurs 'by the book'.

Some interviewees suggested that the problems they described could be addressed within existing asset management practice.[43] More often though,[44] it was held that a different approach was required:

> *It's more than asset management* […which] *is quite simply what do you own, what condition is it in, and how much money do I need to spend* [...] *to keep it going? This is about* [...] *looking at how* [...] *the benefits* [in] *the business case actually roll out and are affordable in terms of maintaining and renewing that new asset.* [PR16]

Feedback also pointed to the timeliness of this research. Comments suggested that there was now an appetite to start exploring and addressing the complex problems being faced in infrastructure administration.

---

[42] e.g. [PR15], [PR24], [PR26-PR27], [PR32], [PR35-PR37], [PR39], [PR48], [PR50-PR51], [PR53], [PR57-PR58], [PR62-PR63].

[43] e.g. [PR22], [PR25], [PR37].

[44] e.g. [PR15-PR16], [PR18], [PR20-PR21], [PR24], [PR26-PR27], [PR29], [PR32], [PR34-PR36], [PR39], [PR42], [PR47].

3.4 Where to focus

A great many *reasons* were identified for the issue with long-term infrastructure outcomes. The key ones to emerge from the interviews were as follows:

- Knowledge is not being retained within the system nor is it informing future decisions as best it might.
- Infrastructure management is still heavily focused on capital works delivery, and processes tend to be asset-oriented. System-level outcomes are rarely monitored.
- Projects or organisational functions are often ring-fenced.
- Projects are being delivered to ‘operations’, but the operational framework rarely adjusts to accommodate changes arising to the system; either to the hard system or within the organisation (such as specifications in the case of non-standard assets).
- Long-term thinking that integrates physical assets and organisations at the systems level was often seen as a missing necessity.

The interviews also suggested[45] a need to improve processes so that these are focused:

- internally: to address organisational capability and capacity;
- externally: to include infrastructure in its context. Process scope needs to provide for societal, rather than just technical, outcomes; and
- at the system level and on long-term function of the combined whole rather than individual assets.

Given the importance of the infrastructure lifecycle and the relationship to organisational structures and processes (Section 1.1), the manifest content was analysed for lifecycle-related themes. That analysis identified the interfaces *between* lifecycle stages, and therefore organisational divisions and processes, to be the area of greatest concern at this time (see also Edkins & Zerjav, 2014).[46] A

[45] i.e. deduced from the latent content generally.

[46] Whilst other lifecycle interfaces were mentioned, the three listed in Table 3.1 were clearly dominant and considered more than sufficient scope for a PhD.

number of subordinate 'factors' that act on one or more of the interfaces also emerged and were able to be aligned with the differentiated lifecycle themes (Table 3.1; see also Appendix IV for examples from the interviews).

Table 3.1: Analysis of lifecycle factors

Aspect *(Lifecycle interface)*	**Contributing factors**
Strategy/project interface	▪ Articulating benefits.
	▪ Business case boundaries.
	▪ Lock-in/momentum/prioritisation.
	▪ Follow-through/reconciliation with system-level objectives (feed-forward).
Project/operational interface	▪ Handover (feed-forward).
	▪ Transition from asset to system.
	▪ Whole-of-life performance.
Operational/strategy interface	▪ Performance (benefit) monitoring.
	▪ Follow-through/reconciliation with system-level objectives. Feedback to strategy (above).

The interface between lifecycle stages is clearly not a vacuum; infrastructure does not simply leap from one state to the next across its lifecycle. Rather, this is an area of organisation-spanning processes and transitional accountabilities. The challenge that arises in turn is that, whilst much needed, applying a project management or business framework to individual parts of the process in isolation is unlikely to address issues arising from system complexity and interdependencies (Edkins & Zerjav, 2014). Moreover, any approach needs to provide for the dynamic context and long timeframes over which this system operates. Consequently, whilst the interviews show that there are many facets to this area, this is less a series of problems to be solved than an ecosystem to be understood.

3.5 Overview of industry need and focus

The lack of attention being paid to understanding system-level benefits, their relationship to decision-making, and the associated implications of an absent feedback-loop has flow-on effects into areas such as the ability to manage change. The interviews suggest that this has only recently emerged within the general industry 'consciousness' and there is a real need, and appetite, to now address such matters.[47]

Because of the range of possible disconnects within the system, as described, as well as the timeframes involved, any loss of system-level benefits may not be immediately apparent. Interviewees talked of 'legacies' resulting from past infrastructure-related decisions and management choices.[48] However, every example referred to large-scale infrastructure that was less than a century old and therefore notionally within its design life. From the perspective of those managing the infrastructure, this might be viewed as a latent failure. Whereas from a systems perspective, this is an active failure because the infrastructure is not achieving the outcomes intended. But this cannot be known for sure when system-level benefits are not re-evaluated or tracked. This in itself raises a challenge in the balance between looking back to feed forward within a dynamic environment.

A key underlying theme to emerge was the inappropriateness of the dominant project-centric approach to infrastructure management. Interviewees[49] noted what Edkins and Zerjav (2014, p. 15) describe as an "*'execution-orientated' mind-set*" extending beyond project delivery; the linear pipeline of conventional asset lifecycles being ultimately unhelpful to managers immersed in a system of concurrent and overlapping processes and sub-systems. A different mental model

---

[47] e.g. [PR15-16], [PR22], [PR24-PR25], [PR27], [PR34-PR35], [PR37], [PR41-PR42], [PR44], [PR47], [PR50].

[48] e.g. [PR13], [PR15-PR16], [PR18], [PR24], [PR28-PR29], [PR31], [PR33-PR35], [PR37], [PR41-PR44], [PR46-PR49], [PR51].

[49] e.g. [PR15-PR16], [PR18-PR21], [PR24-PR28], [PR30], [PR32-PR33], [PR35], [PR37], [PR39], [PR42], [PR44], [PR46-PR47], [PR50-PR51].

is therefore needed, at the least, for approaching this research space. Whilst not initially tabled with this purpose, the systems lifecycle (Figure 3.1) offers an alternative starting point from which this problem space can be considered and the higher-level implications better understood.

Bosch et al. (2013, p. 116) are of the view that "*despite many efforts to deal with these complex issues facing our society, the solutions so far have seldom been long lasting, because 'treating the symptoms' and 'quick fixes', using traditional linear thinking, are the easiest way out, but do not deliver the solutions*". There is, then, no one solution to a complex problem or problem within a complex system. Instead, it is a matter of identifying, "*leverage points for systemic interventions*", or points where there is the opportunity for a disproportionate change to the system (Bosch et al., 2013, pp. 116, 134). In this instance, these 'leverage points' (and therefore the focus for further research at this time), were identified as the processes that occur within or span the interface between infrastructure lifecycle stages. As many infrastructure organisations are either structured, or their processes are configured around that lifecycle, these interfaces have many more dimensions than might first appear. They themselves form a complex with organisational and process aspects, but present the most advantageous points at which to 'deep dive'.

PART II: DETAILED STUDIES

Are the strategic intent and the day-to-day management of infrastructure systems misaligned, and does this have negative consequences for achieving the desired long-term infrastructure system outcomes?	
Part I: Context	Is there misalignment, and how is this recognised as a problem within the wider infrastructure industry? What are the stories?
Part II: Detailed studies	**How is the misalignment being generated (what are the reasons for the misalignment)?**
Part III: Synthesis	What characterises this misalignment or 'gap'? Given this, what are the implications, if any, for infrastructure administration and long-term infrastructure outcomes?

Part II of this research uses three 'deep dives' (a practice borrowed from strategic-level business practice), to look at the system-level issues through three different lenses. Each lens investigated one of the primary lifecycle interfaces in more detail. The methodological framework that ties the three studies together is therefore the first of the Chapters in this part of the document.

The detailed study analyses have been appended with the aim of improving the narrative of the central research programme. Just as Appendix IV provided examples of interviewee quotes, the appendices associated with the detailed studies (and studies 1 and 2 in particular) provide selected examples from the source material (summarised for brevity). The studies contain detail aimed at assisting practitioners in responding to this research, and have been written with that audience in mind. That said, system thinking requires more than a focus on the big picture, as the systems themselves may be nested (Olmedo, 2010) and hierarchical (Gunderson & Holling, 2002) so a single perspective is unlikely to provide the necessary insights. The detail of each study is therefore a crucial part of research as it assists in the development of understanding and the identification of clues as to the way forward for the system as a whole (Table 2.1).

4 RESEARCH STRATEGY

Because many of the engineer's chief problems have their origin in the management system, perhaps his philosophy should be applied to the management interface that couples engineering to the needs of society.

Forrester (1964, p. 66)

Here, the epistemological domains relevant to this research are considered, before positioning the research and setting out several of the matters that have informed the methodological rationale. These draw on, and meld, approaches from several disciplinary domains (e.g. Complexity Theory, ecology, sustainability sciences, Public Administration, and the wider social sciences). The methodological framework is then set out, which introduces the detailed studies.

4.1 Summary of research need

Part I of this thesis explored the relevant literature and industry perspectives to identify both a theoretical and practical need for research into the strategic intent and management of infrastructure systems. A review of the literature has identified a number of relevant theories; however, none of these appear to have been directly investigated from this perspective, or using the approach adopted here. Moreover, the wider literature laments the very few studies of such theories in practice.

Although rarely failing catastrophically, the infrastructure we have is not performing as expected, nor as best it might, despite the development of innovative engineering, and tools to assist the efficient and effective management of assets. In short, industry interviews indicate that there is a misalignment between the strategic intent and the day-to-day management of infrastructure systems. What is also clear is that whilst strategic planning, project management, and asset management are useful frameworks for their respective lifecycle stages, there are still outstanding implementation issues. Furthermore, infrastructure systems operate across all these stages simultaneously on a day-to-day basis.

Industry feedback in the first phase identified that the interfaces between the various lifecycle stages should be the focus for further research. As infrastructure organisations and practices often align with lifecycle stages, the interactions between them add to the complexity at those interfaces. In addition, the issues raised in the preliminary research appear to be ubiquitous, so will be likely to exercise a cumulative effect on the wider system over time.

The stories garnered from the interviews have provided an insight into how the wider infrastructure industry sees current issues and the factors that shape them. Not all of these have been discussed at this stage; however, they inform the subsequent detailed studies, where they have been used to triangulate results, and to reflect on the generalisability of the findings. It is apparent from the responses that there is not yet a collective awareness that the current issues facing the industry extend beyond projects and programmes to systemic function and performance, but it is emerging. This comes back to the point made by Jowitt (2013, p. 291) that, notwithstanding any emergent awareness, "*what remains to be done is to figure out what that actually means and then to implement it*".

4.2 Methodological underpinning

Epistemological traditions

Engineering and the physical and chemical sciences are often linked to a tradition of empirical, quantitative research (e.g. Holling, 1973; Schön, 1991). Schön (1991) observes too that a positivist, 'technical rationality' has embedded itself in public service organisations (including engineering administration), and that this is the "*positivist epistemology of practice*" (Ibid., p.30). However, he qualifies this by noting that a form of 'professional pluralism' has arisen from the 'messy' reality of high uncertainty and complexity (Ibid.).

Whilst Forrester (1964) laments an apparent partitioning between engineering and management in practice, he nonetheless emphasises the common philosophical approach that underpins both. Indeed, infrastructure and 'town planning' policy/management are evident in the writings of Kautilya from as early as 300BCE (Eraly, 2002), which provides an interesting insight into how embedded the underlying technocratic practices and philosophies may be. Whilst the epistemological traditions have ancient roots, recent engineering and management practice is sometimes seen as a product of the industrial age (e.g. Uhl-Bien et al., 2007).

However, a range of epistemologies exist, and notably there has been a decoupling of epistemology and methodological approach. This reflects the importance of aligning methods with, and having relevance to, the context in question (Feyerabend, 2010; Dainty in Knight & Ruddock, 2008). Accordingly, there is no single, 'right' approach.

Research positioning

This research is iterative and although the detailed studies target specific issues, the overarching research strategy is:

- inductive, having been based on several *a priori* constructs and propositions emerging from prior industry experience, which were probed through preliminary research;
- concerned with open, complex systems and therefore unlikely to lend itself to or be well served by reductionism; and
- aimed at developing a ***sense-making*** theory or model (i.e. it does not expect to enable engineers or managers to "*predict and control their environments*" but rather to respond and adapt to these environments (P. Johnson & Duberley, 2000, p. 40); see also Weick, Sutcliffe, and Obstfeld (2005)).

These characteristics accord with Holling (1973, p. 1; emphasis added), who opines:

> *If we are examining a particular device designed* [...] *to perform specific tasks under a rather narrow range of predictable external conditions, we are [...] more concerned with consistent nonvariable performance in which slight departures from the performance goal are immediately counteracted* [...] ***But if we are dealing with a system profoundly***

> ***affected by changes external to it, and continually confronted by the unexpected, the constancy of its behavior becomes less important than the persistence of the relationships. Attention shifts, therefore, to the qualitative and to questions of existence or not.***

Relevantly, the pluralistic nature of this research *does* align with that recommended for the investigation of complex systems (e.g. Ackoff, 1994; Dainty in Knight & Ruddock, 2008; Syntetos & Jackson, 2011).

4.3 Approaching complex systems

> ***Science is developing concepts of complex adaptive systems* [...] *but* [...] *data gathering* [...] *is not keeping up with the conceptual revolution. The emphasis here is on a more fluid and evolving epistemology built around becoming rather than being, on process rather than structure and on change rather than stasis.***
>
> **Harris (2007, p. 162)**

One of the many challenges with this research topic is the apparent paradox of both its perceived simplicity and inherent complexity (Section 3.2). Ackoff (1994) notes that a complex system loses its integrity when reduced to its constituent parts and thus the parts must instead be considered relative to their function and role in the whole.[50] He also asserts that "*problems should be viewed from as many different perspectives as possible before a way of treating them is selected. The best way often involves collaboration of multiple points of view, a transdisciplinary point of view*" (Ibid., p.187). Snowden and Boone (2007) concur. Their view is that a probing and iterative approach is appropriate in complex environments; inherently such environments cannot be the domain of any one, or even multiple, discernible, disciplines.

[50] See also Hartley and Skeltcher in Hartley et al. (2008). However, this does not constrain or diminish the need to understand the detail, which is vital to the ability to probe and effect change within the system (see Dobbs, Manyika, & Woetzel, 2015; Yu & Bower, 2009; see also Footnote 61). In this context, then, the whole may not necessarily be greater than the sum of the parts as these different 'levels' should be inseparable and inextricably intertwined.

Two points arise from this and inform the research strategy:

- The matter of **trans-disciplinarity**, which the likes of Carew and Wickson (2010), Kessel and Rosenfield (2008), Stock and Burton (2011), Stokols (2006) and others, tell us is more than simply considering multiple points of view. This also includes a practitioner interface, and so is meshed with **Action Research**.
- The need for **a probing approach** from multiple angles/perspectives. This assists with establishing common themes and creates a form of system-level triangulation.

4.3.1 Trans-disciplinarity

Wickson, Carew, and Russell (2006) have synthesised what they consider to be the three distinguishing characteristics of trans-disciplinary research, which are used here to describe the research orientation:[51]

- ***Problem focus.*** Trans-disciplinary research has an explicit intent to solve complex, multi-dimensional problems of the real world with the intent of creating change (Ibid.). This is very much the driver for this research (Foreword and Part I of this thesis).
- ***Evolved/evolving methodology:*** Trans-disciplinary research methods are often drawn from different epistemologies and disciplines (i.e. ‘evolved’), or may evolve over the course of the research (Ibid.). The previous section addressed the pluralist epistemology that underpins this research. Reference is also made to the iterative and emergent development of the research. As will be seen, the methodological framework is more than a conventional mix of qualitative and quantitative research. It melds ‘mixed methods’ with ‘deep dives’ (e.g. Bessant & Stamm, 2007), a practice borrowed from business.
- ***Collaboration:*** The literature often refers to trans-disciplinary research being under taken by collaborative groups of researchers, but also includes research undertaken by research groups or a lone researcher in collaboration with the

[51] Whilst Stock and Burton (2011) identify other characteristics, those either relate to multi-researcher processes, so are not applicable here, or may be grouped under the broad themes expressed by Wickson et al. (2006).

community (e.g. Stock & Burton, 2011; Wickson et al., 2006). There are two points here:

- The ability to draw upon qualifications and practice experience across a range of science disciplines and engineering, including the leadership of multi-, inter-, and trans-disciplinary teams.[52] This research also spans academic and industry boundaries and, upon reflection, would have been unlikely to have been as effective if completed wholly in either domain.
- In this instance, the community in question consists of industry practitioners. The concept of community collaboration therefore overlaps with that of Action Research (Stock & Burton, 2011).

Stock and Burton (2011) describe trans-disciplinary research as a 'holy grail', citing others who express doubt over whether it can actually be achieved. But they also acknowledge there are no clear boundaries between integrated research categories, or gatekeepers of those boundaries. This may be so, but just as Huang (2010) observed in Action Research, trans-disciplinarity has a spectrum of practice and is a research approach, not a method (see also Wickson et al., 2006). In other words, research may be trans-disciplinary without fulfilling a set of normative methodological criteria. This is revisited in the following Section.

4.3.2 Action research

Action Research aligns with a defining characteristic of complex systems (Section 1.2.1) in which the observer is part of the system (playing the game, changes the game).[53] Huang (2010, p. 93) defines Action Research as "*an orientation to knowledge creation that arises in a context of practice and requires researchers to work with practitioners".* Greenwood (in Coghlan (2011)) goes further by explicitly stating that Action Research is an approach rather than a

[52] Multi-disciplinary: Disciplines using their own methodological approaches. Inter-disciplinary: Individual approaches within a common framework. Trans-disciplinary: Integration of different disciplinary methodologies. From Wickson et al. (2006).

[53] Referring here to the chaordic nature of the system (Olmedo, 2010), not the agency of the actors.

method or technique. Both views are augmented by the earlier observation of Dickens and Watkins (1999, p. 127) that Action Research is "*an umbrella term for a shower of activities* ***intended*** *to foster change on the group, organizational, and even societal levels* [... …] *Action researchers, then, generate context-bound, values-based knowledge and solutions from their public inquiries into system problems*" (emphasis added).

Returning to, and supporting the point made earlier with regard to trans-disciplinarity, Boulus-Rødje (2014) observe that normative methods in action research have become *de facto* criteria (i.e. a default definition), concluding that "*if the criteria of action research remain exclusively strict and narrow, a number of action research projects may go unnoticed, as they may not be labeled* [sic] *explicitly as 'action research'*" (p.98).

So, whilst Lewin's initial concept of Action Research included execution, evaluation and learning (Dickens & Watkins, 1999), and whilst change may be intended (Ibid.), the point is that Action Research need not necessarily effect that change. Rather, that is a matter of scope, not a reflection of the classification or orientation of the research. Indeed, Bryman and Bell (2011, p. 415) caution that Action Research "*should not be confused with evaluation research* [...] *which usually denotes the* [ex post] *study of the impact of an intervention, such as a new social policy or a new innovation in organizations*".

For this research, any proposed intervention — let alone any evaluation criteria for that intervention — is not yet known because the research firstly tests whether there is a problem, and then characterises reasons why this might be (Chapter 3). Whilst the detailed studies were chosen on the basis that a problem was likely, so they might well recommend a specific course of action or change, this does not automatically hold for the overarching system-level research. This is because there is no single solution to a complex problem or problem in a complex system. Rather, the system-level research is concerned with the emergence and persistence of relationships (preceding section; Holling, 1973), and what those relationships tell us about approaching the system in the future.[54]

Prescriptive intervention

Notwithstanding the preceding discussion, Action Research must still *intend* to effect change. Therefore recommendation(s) for intervention must, logically, still arise. In this regard, Bryman and Bell (2011), cites Gummesson's observation that Action Research is closely aligned with management consultancy, but reiterates Lewin's original point that Action Research is undertaken *with* practitioners.

As 'collaborative consultancy', the implication is that the practitioners, as the research/consultancy 'client', will still be "*looking for expert advice*" (Appelbaum & Steed, 2005, p. 73). So prescriptive statements, or those that define courses of action, are inherent to Action Research. These imply a normative basis, particularly when exercising judgement.[55] This aligns with the "*theories of action*" espoused by Argyris and Schön (in Bartunek (2008, p. 9)). Moreover such statements do not come from nowhere, and are context specific (see also practical knowing and judgement in Coghlan, 2011; Pohl & Hirsch Hadorn, 2008).

Collaborative consultancy

Practitioners have been involved throughout this research, through the preliminary research (Chapter 3), the selection of the detailed studies, and within the studies themselves.[56] This accords with Fielding and Fielding's view (in Flick, 2002, p. 49)

---

[54] This is the very point of this research (in particular, see proposition 3 (Section 2.1)). Besides which, any intermediate change and its subsequent evaluation may take decades (see [PR60]; Appendix IV, and Syme in Stokols (2006)). It is therefore not within the scope of this research to assess the implications of any change.

[55] Also see Pohl and Hirsch Hadorn (2008), who see trans-disciplinary research as developing "*descriptive, normative and practice-oriented knowledge in order to help solve, mitigate or prevent life-world problems* [sic]."

[56] Discussed later, but for example in detailed study 2, rather than simply handing over the cOPEX schedule for pricing, and whilst Auckland Transport was responsible for how the schedule was 'populated', the process was interactive rather than transactional.

that the "*structural aspects of a problem should be linked with reconstructing its meaning for the people involved*". More materially (see Huang, 2010), the *meaningfulness* of that collaboration can be seen in the level of willing involvement and frankness of participants, the recognition by the study organisations of the need and opportunity for change, and an openness to constructive criticism.[57]

4.3.3 Probing searches and multiple perspectives

Responses to complexity can vary from building more sophisticated models through to slicing or probing the problem from multiple angles to learn from what this tells us (e.g. Astorino-Courtois et al., 2012).[58,59] However, as March (1991, p. 111) observes:

> *Decisions in organizations involve an ecology of actors trying to act rationally with limited knowledge and preference coherence; trying to discover and execute proper behavior in ambiguous situations; and trying to discover, construct, and communicate interpretations of a confusing world.*

The complexity literature advises a probing approach to this challenge (Section 1.2). To return to Yankelovich (Section 2.2), presenting complex issues in a relatively few number of "visions" that *"lay bare the conflicts and inconsistencies*

---

[57] Negating one of the criticisms of Action Research (see Hinings and Greenwood in Bartunek (2008).

[58] Ackoff (1979) attributed the apparent demise of operations research to the prevalence of mathematical models and algorithms, often arising from the principles of Game Theory.

[59] For completeness, it is noted that Decision Theory (notably the corpus of Kahneman and Tversky) was explored as part of the development of this research. Similarly Game Theory (e.g. Bernoulli (1738/1954); von Neumann and Morgenstern (2007); and Black (1969)) was considered as a possible research tool. Decisions are an integral part of the contextual fabric (hence, its inclusion within the literature review). But because the focus is upon system outcomes and the role of engineering practice in this, the current approach was favoured. Furthermore, Seddon (2008) is of the view that Game Theory promulgates the 'command and control' perspective, noting that this is at odds with the fundamentals of Systems Thinking and the issues being encountered within the public sector.

buried in the technical information", can be an effective means of starting dialogue (Yankelovich in Constanza, 2000, p. 2). Three deep dives[60] fulfil that role within this research.

Deep Dives

Whittington (2006) cautions us that strategy is often seen as a property of organisations, and researched in a way that does not recognise the multi-level nature of strategy in practice. By contrast, and in practice, the organisational 'deep dive' is a diagnostic tool used to gauge strategic performance and cut through organisational practice in detail (e.g. Bessant & Stamm, 2007; Horwath, 2009; Yu & Bower, 2009).

Bessant and Stamm (2007, p. 9) describe the deep dive as a 'search strategy' that is particularly appropriate when faced with the *"fog of uncertainty which characterises a situation of increasing complexity and unpredictability*". They add that with techniques such as the 'deep dive' and "*a mixture of judicious experimentation and a lot of fast adaptive feedback to emerging situations, firms can employ a 'probe and learn' approach*".

Although Yu and Bower (2009, p. 6) describe the deep dive in terms of executive intervention, they observe that a deep dive "*implies a heavy involvement* [...] *with fine-grained and technical specifics, well into the stage of actual implementation of those* [...] *initiatives*". Crucially, they argue that (Ibid., p.8):

> *A deep dive is an effective means to translate a strategic intent envisioned by top managers into organized actions that will be embraced by multiple levels of the organization.*

The corollary being **the deep dive is an effective means of testing whether the strategic intent has been organised into actions that will have meaning at multiple levels.** This has relevance at both the industry/system level and at the organisational level of this research.

[60] An emergent term.

A deep dive has the potential to provide direction and meaning by providing tangible examples and stories within context (Yankelovich's "visions") where conventional approaches have encountered resistance. For example where Yu and Bower (2009) suggest that managers being asked to respond to a new strategic initiative can still feel bound by their existing context at the local level, a deep dive can help to close the 'knowing-doing' gap (Walshe et al., 2010). By providing the link between the old system and the new state or direction being sought (Whittington, 2006), a deep dive must penetrate, and if necessary, challenge normative standards, principles and practice within the organisation, and create new behaviours (Yu & Bower, 2009).[61] Accordingly, the process can help map a pathway and raise awareness and understanding of the issues.

Relationship between deep dives and case study research

There is little methodological discourse on deep dive practice as this is relatively novel as a research tool, and irrespective, is case specific. In essence though, a deep dive is effectively a form of cross-sectional research in which multiple case studies enable the examination of patterns of association (Bryman & Bell, 2011).[62] A case study is a "*detailed and intensive analysis* […of…] *the complexity and particular nature of the case in question*" in which the focus is "*on a bounded situation or system, and entity with a purpose and functioning parts*" (Ibid., p.59-60),[63] and so is particularly appropriate to this research. So, whilst each 'deep dive'

[61] See also Hartley et al. (2008), Yu and Bower (2009) on the drivers of strategic deep dives, and current calls for disruptive systems thinking (Dobbs et al., 2015), all of which call for re-orienting from first principles. Another aspect of this relates to the development of understanding ('consciousness raising') identified by Yankelovich (1991) and the need to address the "*perceived applicability to self*" and "*concreteness and clarity*" of an issue (pp.77-79).

[62] Again, guidance on how research could or '*ought'* to be carried out should not be mistaken for its definition (e.g. Boulus-Rødje, 2014; Feyerabend, 2010).

[63] The inclusion of bounded systems within this definition does not preclude the use of a case study to research unbounded systems. The term merely attests to, and provides another example of, a definable 'case' that is context-specific (Dickens & Watkins, 1999).

is a case study in its own right,[64] these in turn inform the overarching case study that is New Zealand's land transport sector.

So, in addition to the nesting of the case studies here, there is also the matter of the use of the deep dive within a form of 'multi-case, mixed-method research' that needs to be considered. The question is whether multiple case studies, with different methodologies within each, can be used to cast light on a wider issue, and, in so doing, comprise a valid research design from an academic perspective.

Yin (2003, p. 20) answers this by citing, as an example of a multi-case study, research that included nine social programmes as individual cases, all varying widely in focus. Yin advises that the final chapter of that research then presented a cross-case analysis to "*draw generalizable conclusions that could apply to many other programs*".[65,66] As such, the use of multiple studies enables the relationships between the studies to be explored and triangulated relative to system-level matters. Leonard-Barton (1990) and Tyre and Orlikowski (1994) provide other examples where multi-case research programmes have relied upon diverse studies with variable methods within each. Jackson (2009b, p. 1298) observes that "*only a combination of multi-methodology and multi-method practice can cope with the increasing diversity, complexity and change inherent in the problem situations managers encounter*". In short, the multi-case, mixed-method approach, in conjunction with the epistemological positioning of this research, whilst perhaps novel in this particular context, is neither unsupported, nor academically unsupportable (Dainty in Knight & Ruddock, 2008, p. 8):

> *Adopting the principles of methodological pluralism does not render the choice of method arbitrary, but emphasises the context-sensitivity inherent in research design.*

[64] 'Detailed study' has generally been used as 'deep dive' is not in common usage within academic literature and also avoids confusion with the overarching case.

[65] See also Voss, Tsikriktsis, and Frohlich (2002).

[66] Quantitative and/or qualitative multi-case design also need not involve replication (Yin, 2003).

4.4 Methodological framework

The framework that follows is the result of an ongoing process of reviewing and reflecting upon the literature review, industry interaction, and the results of earlier research. The framework aims to probe the workings of the New Zealand land transport system (the 'system' or unit of analysis), including both functional levels of the sector. It does this by conducting deep dives through different organisations/processes that bridge each of the three primary infrastructure lifecycle *interfaces*: notably strategy–project, project–operations, and operations–strategy.[67]

The research framework, then, describes the same basic stages of other 'multi-case, mixed-method' research comprising within-case analyses, followed by a final stage of cross-case analysis (e.g. Leonard-Barton, 1990; Tyre & Orlikowski, 1994; Yin, 2003). The aim is that the framework enables common themes and stories to be established and considers the broader relationships within the system as a whole (see also Table 2.1). This is the point made by Holling (1973), and quoted in Section 4.2, and so provides a means of reconciling the multiple perspectives of Action Research with the trans-disciplinary nature of — not only the research itself — the lifecycle interfaces, organisations, and indeed, the wider land transport sector.

The framework also aligns with the learning theories of Argyris and Schön (in Pahl-Wostl, Holtz, Kastens, & Knieper, 2010) and in particular steps beyond what is known as 'single-loop learning', defined as the "*incremental improvement of prevailing action strategies without* [the] *questioning* [of] *underlying assumptions*" (Ibid., p.574). The research framework enables this through its structure (which, with its potential to transform, links back to Action Research):

[67] Arguably system need and feedback should drive strategy, and therefore the operations–strategy interface would appear first if the lifecycle were being viewed systemically (Figure 3.1). However, a conventional order has been adopted to assist readers.

- By returning to first principles, the individual detailed studies provide an opportunity for underlying assumptions to be revisited "*within a value-normative framework*" ('double-loop learning'; Ibid., p.574; see also Dobbs et al. (2015)).
- In turn, the detailed studies are intended to cast light on the 'bigger picture' to enable underlying values, belief-systems, and mental-models to be reviewed ('triple-loop learning').

4.4.1 Detailed study selection

Deep dives are often described as a means of transecting an organisation or a project (Yu & Bower, 2009). Here, the three primary lifecycle interfaces, rather than the lifecycle stages themselves, or indeed, other matters, emerged as the dominant, or primary areas of interest at this time (Chapter 3).[68] Because the lifecycle is synonymous with organisation structure and infrastructure practice,[10] it affords insights into wider organisational issues and the New Zealand land transport sector more generally. The challenge was to find lifecycle-spanning processes that were connected to both customer outcomes and technical practice. This excluded organisation-spanning, 'in-house' service functions such as finance and human resources.

More particularly, the studies ideally needed to be aligned across several dimensions. This is to enable cross-case themes and stories to be considered at the system level (Leonard-Barton, 1990; Tyre & Orlikowski, 1994) and to provide a link to the hypothesis and propositions (Yin, 2003). So, in order to investigate how the misalignment between strategic intent and the management of infrastructure systems is being generated (and to enable reasons for the misalignment to be identified), processes were selected that:

[68] Areas of interest are expected to change over time as the system and thinking of those within it evolves. This does not negate the value of the deep dives in their own right, but at the same time, this emphasises the importance of the approach and methodology as a sense-making tool for infrastructure systems. This reminds us that coming to 'resolution' (Table 2.1) should not be mistaken for a requirement to define a solution in the sense of the "*culture of technical control*" (Yankelovich, 1991, pp. 7-11).

1. Spanned one of the three primary infrastructure lifecycle stages in a way that included most of the interface-specific ‘contributing factors’ that had been identified by the preliminary research (Table 3.1).
2. Represented a departmental/functional boundary-spanning process within the organisation, and would likely be found, if varying in detail, within the wider sector.
3. Crossed multiple vertical levels in the organisation: from technical principles through to governance.
4. Was of direct relevance to the outcomes experienced by the external customer — even if not currently delivered — and so related to the strategic intent (rather than only a technical objective).
5. Related to wider normative industry practices (ideally that had been found wanting, but not yet resolved).

In the event that there was no formal/singular process, there needed to be sufficient process components within the existing system to enable an equivalent ‘first principles’ assessment to be made.

A range of possible detailed studies were identified over the course of the preliminary research. For example, the Auckland Harbour Bridge and Northern Busway projects were often cited within the preliminary interviews as examples of, respectively, poor and good decision-making. However, these were set aside as being ultimately project-focused, so therefore not suitable. Other interface-spanning processes such as funding, project prioritisation and programming, asset management, and compliance were also considered but either did not emerge strongly from industry interviews and organisational discussions, were too broad, involved processes worked on previously, and/or had evolved significantly since the start of this research.

Accordingly, whilst there may be other processes that might meet the above-mentioned research criteria, an opportunistic approach was adopted to ring-fence three studies before they were subsumed into ongoing improvement initiatives. This is a dynamic system, so organisations and the wider industry do not remain static whilst cases are identified or research is conducted (underlining the importance of involving practitioners).

Both benefit management and ‘consequential operating expenditure’ (cOPEX; defined in Chapter 6) were explicitly named on more than one occasion during the preliminary interviews (e.g. see Appendix IV). In the end, these two processes — along with the well-ingrained industry performance measure of road smoothness — were deduced as being suitable for further research after the scope of each was refined in discussion with practitioners (Tables 4.1-4.3).

Table 4.1: Summary of detailed study 1

System benefit management		
Aspect** (lifecycle interface)**:	Strategy/project interface.	
Brief description:	How strategic connectivity and benefit visibility at board level interrelates with projects.	
Organisation:	Auckland Transport (local government organisation).	
Level:	Strategic.	
Scale:	Macro.	
Coverage of ‘contributing factors’:	▪ Articulating benefits.	✓
	▪ Business case boundaries.	✓
	▪ Lock-in/momentum/prioritisation.	✓
	▪ Follow-through/reconciliation with system-level objectives (feed-forward).	✓
Methodology:	Cross-sectional analysis through current practice, including analysis of: a) connectivity of current organisational strategies and directives/how strategic intent transitions into strategy; b) benefit visibility within board reporting/how strategic intent and benefits (outcomes) are reported and managed within the governance context;	

System benefit management	
***Methodology** (Cont[d]):*	c) how benefits have been managed and transition within the project context. Plus a cross-analysis/synthesis of the implications for the strategy to project interface.
Notes:	▪ Links to strategic intent via strategic plans and project objectives. ▪ Auckland Transport has recently melded best practice from across 1 regional and 7 local councils. ▪ No formal process in place (project-level benefit management under development). ▪ Links to wider land transport funding and strategic objectives as local government must demonstrate 'strategic fit' as part of New Zealand Transport Agency (NZTA) funding applications (NZTA, 2013a). ▪ Benefit delivery is of shared concern in wider New Zealand land transport organisations and across other infrastructure sectors (Chapter 3).

Table 4.2: Summary of detailed study 2

Whole-of-life management	
***Aspect** (lifecycle interface):*	Project/operational interface.
Brief description:	Post project delivery, operational estimating of the cOPEX arising from new projects and programmes.
Organisation:	Auckland Transport (local government organisation).
Level:	Operational.
Scale:	Meso.

Whole-of-life management		
Coverage of 'contributing factors':	▪ Handover (feed-forward).	✓
	▪ Transition from asset to system.	✓
	▪ Whole-of-life performance.	✓
Methodology:	Cross-sectional analysis through current practice, including: a) analysis of project documentation to collate operational costs and trace how obligations have been managed and transition through the project development; b) first principle development of cOPEX schedule and comparison against other current estimates; c) cross-analysis of the implications for the project to operations interface.	
Notes:	▪ Links to strategic intent via project objectives, operational budgets, and scope/levels of service. ▪ Auckland Transport has recently melded best practice from across 1 regional and 7 local councils. ▪ No formal process in place. Auckland Transport has recently completed an asset-based estimate of the first stage of a significant programme, enabling comparison across estimating techniques and approaches. ▪ Long-term costs are an identified issue for New Zealand local authorities in general (Controller and Auditor-General, 2014a). Whole-of-life costs were also identified as wider infrastructure issue (Chapter 3). ▪ Links to wider land transport funding as local government must calculate whole-of-life costs as part of NZTA funding applications (NZTA, 2013a). Wider deliverables must also demonstrate strategic fit with overarching objectives	

Table 4.3: Summary of detailed study 3

Performance management		
***Aspect** (lifecycle interface):*	Operational/strategy interface.	
Brief description:	Road smoothness as an indicator of the strategic objective to improve customer comfort.	
Organisation:	NZTA (central government organisation).	
Level:	Tactical.	
Scale:	Micro.	
Coverage of 'contributing factors':	▪ Performance (benefit) monitoring.	✓
	▪ Follow-through/reconciliation with system-level objectives. Feedback to strategy (see Table 4.1).	✓
Methodology:	First principle reassessment of current practice, including: a) workshops with infrastructure customers to canvass issues and to focus/pilot more comprehensive assessment; b) national survey of customers; c) assessment of the implications for the operations to strategy interface.	
Notes:	▪ Links to strategic intent as a performance indicator for a strategic objective. ▪ Road smoothness is a widely used national and international indicator. As well as being a measure of customer comfort by the NZTA (NZTA, 2011, 2014a, 2015a), it is a mandatory reporting measure for local government in New Zealand (Department of Internal Affairs, 2013). ▪ Performance management identified as a wider issue for New Zealand land transport organisations and across other infrastructure sectors (Chapter 3).	

To reiterate an earlier point: the studies do not purport to cover everything, but rather aim to probe and diagnose the system by slicing the system/problem vertically. In doing so, the studies intersect the hierarchic or nested layers of practice at the macro, meso, and micro level (Newell et al., 2005; Van de Ven, 1976).[69] This is notable, because, as Hitt, Beamish, Jackson, and Mathieu (2007, p. 1385) tell us that:

> *Most management problems involve multilevel phenomena, yet most management research uses a single level of analysis. A micro or a macro lens alone yields incomplete understanding at either level. Multilevel research addresses the levels of theory, measurement, and analysis required to fully examine research questions* [...] *To enrich the impact of future management research, we recommend (1) applying multilevel designs to existing models (2) considering bottom-up effects, (3) collaborating across disciplines on multidisciplinary topics, and (4) addressing major real-world problems via multilevel approaches.*

A summary of the overall methodological framework is given in Figure 4.1.

One methodological point to emerge once the final detailed studies had been selected related to the relevance of the methodology to the infrastructure lifecycle as a whole. The lengthy duration of the infrastructure lifecycle would generally preclude longitudinal studies except in retrospect as an historic review. However, every piece of infrastructure will pass through the three lifecycle interfaces and the broad processes to be researched here. Whilst the exact details of the process may differ and, for example, whilst the metric might not be road smoothness, there will be some form of performance monitoring. So, even though the detailed studies are contemporaneous, the research framework offers a form of longitudinal study. This is not of a singular asset or network, but rather, of how the processes direct that infrastructure and its services (outcomes) to be managed.

[69] As such, this is different from reductionism.

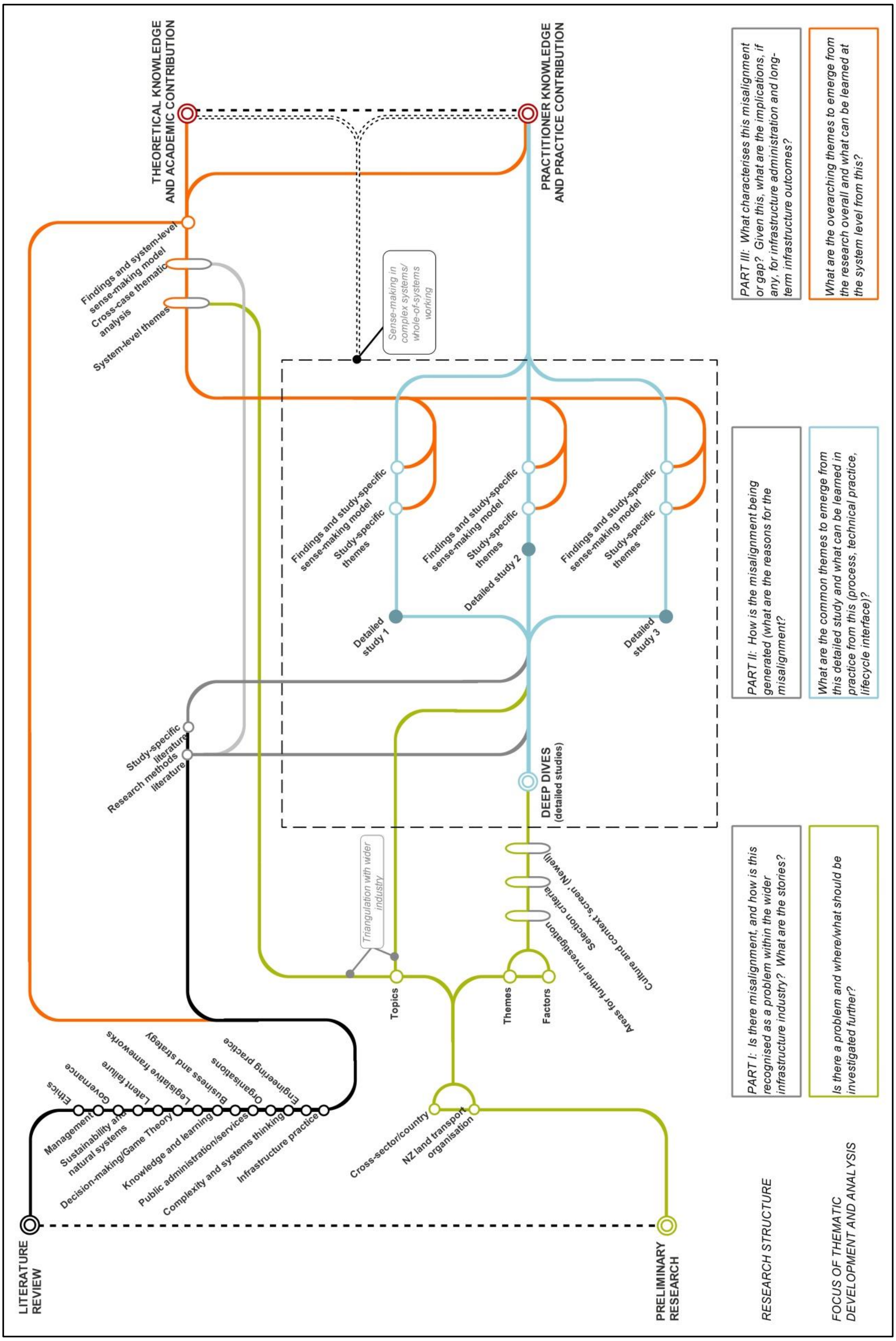


Figure 4.1: Methodological framework

4.4.2 Methods

In addition to the matters covered within Section 4.2, guidance on case study research is provided by the likes of Easton (1992), Eisenhardt (1989), Farquhar (2012), Fiss (2009), Hartley (2004), Thomas (2004), and Yin (1981, 2003), and has been integrated into this framework. Flyvbjerg (2006) also neatly identifies — and then dispels — five common misconceptions of case study research. From this, it can be concluded that there is wide acceptance within the literature that studies of this type have a valid and useful place in research.

Detailed study methods

Each detailed study adopts a subject- and context-specific methodology (Tables 4.1-4.3), the methods for which are detailed within the relevant chapter.[70] The studies deploy a variety of tools to provide within-study triangulation, and this includes drawing upon the preliminary research material to provide a check on external validity and the wider applicability of the emerging stories and themes (Yin, 2003).

The studies are also approached from first principles to enable normative practice to be investigated. As such, whilst the studies investigate the relationship between strategic intent and the management of those processes in detail, the studies are not an audit in the sense of a box-checking exercise against a given set of strategic objectives. Rather, this is about sense-making and the detail is necessary transect and probe this space to uncover stories (aesthetic knowledge; Section 2.2) — and also evidence — such that it has meaning and relevance to practice as well as in theory (Sections 1.1, 4.2.3, and Footnote 61).

Each of the studies generated a wealth of data, which were detailed within a series of standalone ‘reports’ to capture the analyses and results in a transparent manner, and assisting practitioner discussions. The reports were then summarised into a

[70] Also see Appendix III: Research Management.

thesis chapter, and further summarised for publication,[71] wider dissemination and uptake (see Table 2.1 and Section 4.3.2).[72,73]

Only the material that relates directly to the main findings for each of the studies has been presented within this thesis for brevity. For this reason, only selected evidence/examples/stories are included within the appendices. There is therefore ample scope for other matters to be addressed at a later date.

Cross-case analysis

At the completion of the detailed studies, the findings from each were reviewed, and key themes identified and synthesised into groups for cross-case assessment by manual ‘cutting and sorting’ (Ryan & Bernard, 2003). This involved reappraising the earlier material from a system- rather than study-specific perspective. ‘Meaning’[74] was therefore reviewed afresh and resulted in many of the themes being reworked and regrouped. Accordingly:

- the themes from each detailed study do not necessarily align with the system-level cross-case analysis; and
- reworking of the themes in this manner does not render the thematic assessment of the individual studies invalid, as the cross-case assessment was not looking within the deep dive but rather looking for system-level relationships and stories. These are not mutually exclusive or contradictory.

[71] Blom, De Marco, and Guthrie (2015) and Blom and Guthrie (2015, 2017b, 2017c).

[72] Other papers generated by this research include Blom and Guthrie (2016, 2017a, 2017d, 2017e).

[73] Except as noted, the papers stemming from this research do not include material that is not otherwise covered by this thesis.

[74] From the source material but now in the context of the system (see Section 3.1).

5 DETAILED STUDY 1

SYSTEM BENEFIT MANAGEMENT

This first of the three detailed studies investigates the strategy to project interface of the infrastructure lifecycle. It considers how the misalignment between the management of infrastructure systems and its strategic intent is being generated across the first of three processes to span key lifecycle interfaces or transitions (Tables 2.1 and 4.1). As such it is aimed at providing clues or analogies to develop an understanding of the issues. The material, in turn, provides the evidence-base and inputs for the subsequent cross-case analysis that is to follow within Part III.

Brief description: How strategic connectivity[75] and benefit visibility at board level interrelates with projects.

Strategic intent: This detailed study explores the delivery of strategic intent within the hierarchical organisational and plan structure of the Auckland region of New Zealand (see Appendix I). In this context, Auckland Transport, as a Council Controlled Organisation, is charged with aligning with the wider plan objectives (strategic intent) of the Auckland Plan (Auckland Council, 2012a) and specifically the delivery of Auckland Council's transport related objectives:

- A well-connected Auckland (create better connections and accessibility within Auckland,

[75] Being the connectivity between directives within the higher order statements of strategic intent of Auckland Council and subordinate statements of strategic intent within the study organisation (Auckland Transport; as a Council Controlled Organisation).

across New Zealand and to the world).

- Transformational shift: Move to outstanding public transport within one network.

Contributing factors investigated (see Table 3.1):

- Articulating benefits.
- Business case boundaries.
- Lock-in/momentum/prioritisation.
- Follow-through/reconciliation with system-level objectives (feed-forward).

Organisation: Auckland Transport (local government organisation).

Much of the current attention given to benefit management targets project delivery. By contrast, this study considers system-level benefit management and the ability to sustain strategic intent once a given project or programme has been decided upon. This is not an investigation/audit of project deliverables. Rather, the focus is upon the underlying mechanisms and how system-level benefits are managed through the strategy–project interface. The study investigates why the matter of benefits might be so problematic, and in what way this might affect the integration of projects into the extant system.

5.1 Introduction to benefit management

Although benefits are intrinsic to infrastructure and the public sector, benefit management still remains an area of concern to the wider infrastructure industry. For example, as part of the preliminary research (Chapter 3), benefit management was found to be a commonly shared issue, observing in the ensuing journal paper that (Blom & Guthrie, 2017e, p. 9):

> *While the overarching issue relates to the long-term performance of infrastructure and thence the alignment of infrastructure governance and operations, this really amounts to how organisational structure and business practice define or shape engineering decision-making and infrastructure outcomes. Benefit management* [...] *processes probe and transect this space and have been highlighted as areas for further investigation.*

This Chapter advances that earlier research by investigating system-level benefit management in further detail. It does so by using New Zealand's publically owned land transport as the subject of the research, and focuses on Auckland Transport, the entity responsible for transportation management in New Zealand's largest region (see Appendix I for further background). Auckland Transport has planned a capital investment programme of NZ$60B[76] over the next three decades (Auckland Transport, 2013a).

This research assesses governance and strategic practice, together with how these interrelate with project-level benefit management. However, this study does not purport to calculate the benefits of a project or of the system. Rather, the approach provides a methodological tool for assessing the effectiveness and 'fitness' of processes that are being deployed to calculate, manage and deliver the benefits of transportation and other infrastructure systems.

Benefit management and land transportation

According to Breese (2012) and Tillmann, Tzortzopolous, Sapountzis, Formoso, and Kagioglou (2012), benefit realisation has relatively recently emerged as a mainstream management paradigm out of the technology sector. A number of frameworks and tools have since been advanced to assist benefit management. Some are aimed specifically at the public sector, so have been integrated into project/programme management, policy, and practice (e.g. May, Sapountzis, Yates, Kagioglou, & Aouad, 2009).

New Zealand has followed suit by adopting the UK's Gateway review process (State Services Commission, 2010, 2013a, 2013b, 2013c, 2013d, 2013e). Benefit management, as an identifiable discourse, with its associated milestone hold points should, therefore, be entering the language of the public sector. Within New Zealand's public transportation infrastructure providers, such as the local government entity studied here, this should — in theory at least — be less of a watershed because:

---

[76] At the time of writing, NZD$1 equalled approximately USD$0.73 or GBP£0.55.

- benefit Cost Ratios (BCRs) are a prevalent investment decision-making tool (e.g. NZTA, 2013a), and in New Zealand, transport investment now also includes assessment against strategic fit (NZTA, 2015a); and
- projects are often required to demonstrate that "*the work and designation are reasonably necessary for achieving the objectives of the requiring authority* " (Schedule 4, and s168A(3)(c); RMA, 1991).

Notwithstanding the point here, that benefit 'calculations' are an embedded practice for the transportation sector, it is surprising that benefit realisation would, or could, ever be viewed as an emergent paradigm for any infrastructure sector at all. Yet this would appear to be the case. The definition of infrastructure (Section 1.1) inherently presupposes any outcome to be positive and, therefore, that projects deliver or renew benefits, and the operations division then service, maintain, or enhance those benefits over time. An infrastructure benefit then, is simply that which is for the good of, improves, or helps forward that society or enterprise ("Oxford English Dictionary (online version)," 2014).

Of course none of this implies that benefit delivery has been, or currently is, exemplary. Moreover, some of the project-oriented frameworks may be problematic because transportation infrastructure exists as a complex *system* (Section 2.3), and:

- projects and programmes may inherently rely on the delivery of other projects or services (sometimes between different departments or entities) to enable benefits to be realised (Chapter 6);
- projects and programmes are predominantly delivered to effect change to (i.e. benefit) an existing infrastructure system. Once absorbed, benefits may no longer be able to be sufficiently differentiated or may be 'explained away' (Flyvbjerg, Skamris Holm, et al., 2003);
- transportation systems exist as a long-term continuum that can extend far beyond the initial design life of the hard assets (Quinet, 2011); and therefore
- strategy is formed incrementally through a non-linear and concurrent process of analysis, formulation and implementation (Thiry & Deguire, 2007).

This suggests that whilst benefits might be expressed as broad, societal (i.e. ‘system-level’) objectives, there is a need to move beyond the current project-oriented view that ultimately informs subsequent processes within project, programmes, and the wider organisation (Chapter 3). However, changing focus can be challenging, especially when ongoing growth and economic prudence drives a demand for improved project management practices and rigour. Furthermore, adherence to a project perspective is often unhelpful. For example, Lenfle and Loch (2015, p. 7) contend that the stage-gate approach, which underpins current project management practice, is problematic because:

> *This rational view of project management oversimplifies the processes at stake, particularly for innovative projects and megaprojects with their inbuilt unforeseeability (because of long time frames and stakeholder complexity). Moreover, this leads* [...] *to misinterpretations of the success factors of these projects.*

Another emergent general management trend, the ‘project-based organisation’ (Hobday, 2000; Thiry & Deguire, 2007), arguably the status quo for many infrastructure organisations, will only serve to reinforce project-oriented practice. If an organisation (and the infrastructure it manages) is, itself, viewed as a form of mega-project, then these problems might be similarly expected, even if expressed at different scales and timeframes.

Study context

Auckland Transport’s strategic context is largely defined by the requirements of the Local Government Act (LGA; 2002) and the Land Transport Management Act (LTMA; 2003). The two statutes establish the high-level relationships with central government policy, and the local government aspirations and plans as articulated by Auckland Council. Although the overarching statutory requirements are germane and taken into account, the key Auckland Transport strategic documents focus on giving effect to the Auckland Plan (Auckland Council, 2012a) in the first instance. This establishes a document hierarchy in which ‘lower order’ plans must give effect to ‘higher order’ ones (see Appendix I). Accordingly, there is an expectation that specific detail will be provided within tactical plans in response to, and in alignment with, the broader requirements of policies and directives.

The Integrated Transport Programme (Auckland Transport, 2013a), which sets the strategic direction within Auckland Transport and responds to the Auckland Plan, was issued after the initial release of the first generation of subordinate plans such as the Regional Land Transport Plan (Auckland Transport, 2012a). Many of Auckland Transport's plans require review on a three yearly basis and so are now in their second generation.

This study also uses material from a significant capital works programme that was underway in Auckland at the time. A brief overview of the Auckland-Manukau Eastern Transport Initiative (AMETI) may therefore be found within Appendix V.

5.2 Detailed study 1 methods

This study transects the organisation by completing a 'deep dive' through three levels of benefit management:

- how benefits are framed in strategic documentation;[77]
- how visible benefits are at board level (benefit visibility); and
- what happens to benefits within projects (project-level benefit management).

The final step was to investigate the extent of change likely to be required to respond to the research findings (influencing change).

Strategic interrelationships

The purpose of this step was to understand how Auckland Transport has structured its strategy, and how that interrelates with the Auckland Plan. To do this, policies and directives were noted from key documents, along with how these cross-referenced policies and directives within other documents. The strategic documents considered were the:

- Auckland Plan (Auckland Council, 2012a);

[77] Specifically, the interrelationship between the strategic intent of a higher order organisation/plan and the underpinning strategic intent and high-level strategy of a subordinate organisation and its key strategic documents.

- Integrated Transport Programme (ITP; Auckland Transport, 2013a);
- Asset Management Plan (AMP; Auckland Transport, 2015b);
- Regional Land Transport Plan (RLTP; Auckland Transport, 2015c);
- Regional Public Transport Plan (RPTP; Auckland Transport, 2015f); and
- Parking Strategy (Auckland Transport, 2015e).

Social network tools (e.g. Gephi) are available to help map such relationships, connections, and even values (e.g. Allee & Schwabe, 2009), and have been used to this end later in this study.[78] However, because disconnects between strategic documents are also of interest here (something that is not so apparent within a complex social network map), a different approach was required to assist the detailed analysis.

The outputs were instead drawn in EDraw Max, a programme that has tools to enable the connections to be drawn to look like a subway or metro map. A subway map was chosen for stylistic and clarity reasons (notably the ability to highlight disconnects as 'terminating stations'). This took time as the 'map' was not automatically generated from a list of connections, but had to be built. So, overall 'network' form is not important here. What is crucial are the linkages that Auckland Transport has itself defined in its documents enabling both relative connectivity and disconnects to be readily and systematically identified.

Performance measures were also mapped for the same documents plus measures from the two latest versions of Auckland Transport's Statement of Intent (Auckland Transport, 2014d, 2014e). The Statement of Intent (SOI) documents the short-term agreement between Auckland Transport and its parent organisation, Auckland Council. As many of the 'second-order' plans specifically referenced the performance measures within the SOI, the SOI was included for completeness in this step.[79] The mapping exercise has provided a useful way of understanding the

[78] Visually augmenting the descriptive analysis (Trumbo, 1999).

[79] The SOI was not included within the initial strategic framework map, as the SOI is meant to articulate the short-term actions that give effect to the long-term ITP.

implications arising after significant shifts in strategy were noted between two different versions of the SOI.

Benefit visibility

825 board reports were available from Auckland Transport's formation in November 2010 to December 2015. Of these, 765 were in an interactive PDF format that allowed the documents to be coded. The excluded documents were either file dividers (titles only) or short financial statements, neither of which affected the commentary that follows.

The 'manifest content' (Section 3.1) was coded in NVivo, this time according to a predefined schedule to enable the relative coverage of areas of interest to be compared:

- benefits;
- infrastructure lifecycle/organisational structure:
  - strategy;
  - operations;
  - capital development;
- performance and feedback;
- AMETI visibility.

Benefits and performance reflect the key dimensions of first stage of this detailed study, and AMETI, provided a link to the third stage of this study. The functional divisions were chosen to support the system-level analysis.

Whilst the manifest content analysis provided a systematic assessment of the documentation, it must, by its very nature remain qualitative in essence, so has not been reported directly. This is because the actual percentages cannot be generalised; there is nothing to suggest that any given percentage is appropriate or otherwise. However, the assessment provided a quantitative basis for describing relative trends (i.e. 'more' or 'less' coverage), a means of sifting data, and a framework for assessing the 'latent content' (Section 3.1).

The coding process also assisted in readily extracting examples from documents as evidence to support the detailed analysis. The predefined codes were supplemented with emergent sub-themes. These were then grouped into thematic clusters for further consideration (again, using the processes described in Section 3.1). Accordingly the results are structured to firstly follow the coding schedule before moving on to the other matters to emerge from the analysis.

Project-level benefit management

This step entailed an overview of 128 available project documents to enable key issues to be identified. Rather than coding the documents directly in NVivo, in this instance it was simpler to firstly tabulate issues within Excel before sorting these into themes (Section 3.1). Project-specific material was then augmented by:

- Prior organisational case studies. Previous Auckland Transport or legacy organisation projects that have relevance to this study.
- Preliminary research interviews (Chapter 3).
- An additional 7 semi-structured interviews with staff from across Auckland Transport, including the Programme Director, as well as senior consultant advisors (see Appendix II). These were to source and clarify information, and to seek views on preliminary observations.
- Observations from the data gathering and review process, and the literature available from Auckland Transport over the course of this study.

System-focused Appreciative Enquiry underpinned the approach, so this study explores the extent to which benefits are already articulated and managed within existing practice, then investigates disconnects (if any). The aim was to identify a range of factors that could affect the benefit realisation process and therefore the ability to deliver the benefits being sought.

Influencing change

A one hour workshop was held with two senior Auckland Transport specialists (August 2016) to canvass the range of matters that would need to be changed or addressed in response to this study (see Appendix II). The issues were captured by the Auckland Transport workshop participants on a whiteboard as a mind map. The workshop output was then replotted using Gephi networking software, which enabled the relative connectivity of issues/actions to be highlighted, establishing a hierarchy to assist the organisation prioritise its response.

The outputs could inform and help the organisation to prioritise change, as highly connected points are likely to create ‘leverage’ or to have a disproportionate effect upon the system. To this end, the workshop also served as a consciousness raising exercise and ‘socialised’ the issues and concepts.[80] Whilst Auckland Transport has advised changes have arisen already as a consequence of this work (Section 9.2.2), implementing any change is not part of the scope of this research (Chapter 4).

5.3 Detailed study 1 results

The results of this detailed study are attached within Appendix VI, which includes examples from the available documentation to support and augment the analysis. For brevity, only those key matters have been included which provide a link to the key themes set out below and within the discussion to follow.

5.3.1 Strategic interrelationships

Presenting the organisation’s strategic and performance management frameworks as a simple ‘map’ (Section 5.2; Figure AVI.1 and Figures AVI.3-AVI.4) proved a useful analysis tool. As Auckland Transport was not wholly clear how their strategies fitted together, it was also useful for socialising the findings. The mapping technique therefore has potential to be of use to this, and other infrastructure organisations to understand, check, and communicate strategic direction.

As a general observation, Auckland Transport’s strategies are dominated by the hard infrastructure typology through either asset management or capital

[80] ‘Socialising’ is broadly an organisational ‘teaching/learning’ process (Van Maanen & Barley, 1982), which can be useful in change management, and/or in gaining acceptance/uptake of new or challenging initiatives. See also Yankelovich (1991); Yankelovich and Friedman (2010), and Section 2.2.

development. Service-related strategies are largely absent or reduced to general satisfaction surveys within performance measures. The study also found that strategic frameworks can be undermined by factors such as:

- The relative timing of strategy development. In this instance the hierarchy appears to have been immediately compromised by the order in which documents were produced.
- The ability to manage change. This includes the iteration and review of strategy, and the ability to synchronise and align documents. The inability to follow 'threads' throughout the system exacerbates disconnects within the strategic framework (proposition 3).
- The promulgation of new strategies, and measures.
- The ability to understand, connect, and align all parts of the system, namely: documents, strategies, measures, and then among all three layers. This is more than a matter of complexity, but requires a purposeful documentation of explicit links so that meaning can be communicated and connections understood. Connectivity is important for several key reasons:
  - Whilst linkages might be inferred, these can be open to interpretation, whether between organisations, departments, or by stakeholders. So this requires more than the application of 'common sense' for transparency and strategic direction.
  - The more connected a strategy or measure, the greater the visibility within the organisation. This relates to the matter of salience (Magness, 2008; Mitchell et al., 1997; Neville, Bell, & Whitwell, 2011; Neville, Menguc, & Bell, 2003). Strategies or initiatives that become isolated are at risk of being omitted due to lack of visibility within the wider system.
  - What is more, transparency would enable outcomes to be evaluated across multiple levels of the organisation — recalling that performance measures do not measure or target everything — and enable organisational learning and (r)evolution.
- The complexity of the strategy and therefore the inability to clearly communicate requirements and how everything fits together (i.e. 'how do I contribute?').

These factors affect transparency, accountability, follow-through, and thence the ability to review, learn, adapt, and evolve.

With the strategic framework having the potential to be compromised in this way, there is, in turn an issue for the management of outcomes, as there is nowhere for project-level benefits[81] to tie into the strategic framework. There are simply too many disconnects.[82] Subsequently, even with a stage-gate assessment of benefits, the contribution to the overarching system-level objectives may not be able to be ascertained or have much meaning.

5.3.2 Benefit visibility

Nadler and Tushman (1980), amongst others, argue that goal attainment is one of the fundamental pillars of organisational performance. At face value, then, one would expect benefits to be highly visible within board documentation given the key role of governance "*is to ensure that corporate management is continuously and effectively striving for above-average performance, taking into account risk*" (Australian Independent Working Party into Corporate Governance, in R. Grant et al., 2011, p. 55).

Yet in the subject organisation:

- benefit management is not highly visible at board level;
- there is both a disconnect and a lack of transparency between strategic intent and the proposed benefits of projects or initiatives; and
- reported follow-through and feedback is virtually non-existent, or not reported in a way that that suggests the organisation retains knowledge or enables organisational learning and adaptation.

The organisation and its board are clearly aware of some of these issues and are trying to effect a culture change. There is, for example, a project audit framework (which includes benefit realisation), and there are examples where benefits were being actively managed within parts of the organisation. There has also, more recently, been a greater focus on operations and service delivery than was seen within strategic documents.

[81] Arising from capital development *and* operations.

[82] See Appendix VI, Section AVI.1.

However, just as the strategy is dominated by the hard infrastructure typology, board documentation is dominated by features, which become little more than a list of actions and outputs in the absence of clearly established benefits and feedback loops (and is reinforced by the current form of the strategic documents). This 'red queen-like' busyness without a sense of progress has been noted by Auckland Transport's shareholder (Auckland Council) and in the public's submissions to strategic plans.

What is also not clear from the available documentation is how the individual parts of the organisation and network act upon each other and influence the benefits at the system level. This was particularly apparent in the way performance indicators were reported; there was no sense that the whole of the organisation considered how their actions either benefited or adversely affected strategic goals (proposition 2). Finally, the documentation often relied on inference or superficial assessment in areas such as:

- between strategy and performance indicators, projects, or actions;
- project alignment with, or interpretation of, strategy;
- the inherent 'goodness' of a project, action, or technical process (e.g. BCR).

This curtails the unbundling of project benefits, transparency, and feedback, and thence organisational/system-level knowledge retention, learning, and accountability. Consequently, project-level benefit management can only be one part of the solution and in itself is unlikely to result in the improvements to the system-level infrastructure outcomes being sought.

5.3.3 Project-level benefit management

At the project level, it appears that this matter is as much about the benefit realisation process, as it is about realising that there are benefits (and dis-benefits) to be managed, and that those benefits:

- are the primary focus for the project or programme;
- are externally focused;
- unfold in detail as the project advances;
- may still evolve and change over time;

- exist at multiple levels and respond to many functional (e.g. organisational department and technical discipline) needs; and
- have several dimensions that respond to customer need, beliefs, choice, and aptitudes.

Stage-gate frameworks are therefore all well and good, but as Lenfle and Loch (2015, p. 2) point out:

> *The performance track record of megaprojects is dismal, even though the basic ingredients of successful large project management are not new. Put simply, the trick is to combine uncertainty in dealing with the difficulties of long time horizons and non-standard technologies with stakeholder complexity as expressed through the involvement of multiple powerful interested parties (Flyvbjerg and Cowi 2004).*

It might be trite, but as this study has shown, it is necessary to add: whilst retaining focus on the intended, right, and/or all benefits.

Whilst there are many challenges with the delivery of complex infrastructure projects and their benefits (e.g. as examined by Bertolini & Salet, 2008; Flyvbjerg, Bruzelius, et al., 2003; Lenfle & Loch, 2015; OMEGA Centre, 2012), those benefits are ultimately directed at a third, often amorphous, party: a community or society at large. Irrespective of any community consultation or collaboration by the organisation or project team, those stakeholders do not often have a strong voice within the organisation itself. Furthermore, their organisational proxy — the operational divisions of an infrastructure organisation — also do not seem to be actively involved to provide the voice of 'the client'. Alternatively, there is the risk that the operational focus is upon moving traffic, freight, and/or buses. In other words, *things* rather than people.

It is also telling that benefit management was delegated to the financial team, inherently aligning the benefit management process with the investment and funding decision. This may be necessary at one level; however, whilst benefits are assessed at the project-level as part of investment and statutory decision making processes, this is not necessarily addressing system-level outcomes. The benefits as assessed by a BCR might be useful in an *ex post* assessment and review of benefit delivery, but should not be assumed as the complete picture, as benefits need to be considered from multiple perspectives and through many levels. Whilst the BCR notionally provides for a wide range of benefits, these can be mired in the focus upon traffic modelling, or receive less attention because wider benefits may be:

- less familiar, or less readily able to be quantified;
- omitted or given cursory attention because traffic-related benefits were deemed sufficient to get the project ‘over the line’.

Dis-benefits, too, need to be managed and this is not necessarily the same as risk management or the weighing of the benefits versus the disbenefits of project options (Breese, 2012). Something more active is required. For example, in the New Zealand context, statutory processes are likely to include requirements that avoid, remedy or mitigate adverse environmental effects (Appendix I). Consequently, the benefits needing to be managed may have a different focus and scale from those aimed at the system or strategic level.

Similarly, there is no process for managing ‘deferred benefits’ (explored in detail within Chapter 6). This study reiterated the importance of deferred benefits, and their links to how benefits are perceived, framed, and communicated, giving rise to a belief that certain benefits have been delivered or ‘problems sorted’. Overcoming the inertia that this creates, let alone any funding shortfall, can be challenging.

Finally, the following matters also emerged from the analysis:

- ***Feedback:*** There is currently no mechanism to provide feedback to the project team even though benefits and organisational reputation were two of the attributes upon which project success would be judged.[83] Information and assumptions used to assess and approve the project are not re-used (and so tested), and necessary benchmark or baseline information obtained to enable the necessary comparisons to be made. It was felt that there would be a

[83] Doz and Kosonen (2014) describe this as strategic atrophy.

reluctance to actually complete such an assessment as the project/organisation would be found wanting.

Ex post feedback was sought from the community surrounding the project (Board visibility; Appendix VI). However, this appeared to extend to generic satisfaction surveys. One problem with customer satisfaction surveys is that they are really only asking about the customer's satisfaction with the asset. This is not the same as asking whether they are satisfied that it helps them with their lives (see Chapter 7). So, although the project was predicated on achieving a significant modal shift (Auckland Transport, 2013b), this does not appear to have been explored by, for example, asking the community whether they now *believed* that they could give up a car (and if so, why/if not, why not?). Such a question, and change in focus, would have enabled ongoing learning and goal-seeking behaviour as advocated by the likes of Pahl-Wostl and Ackoff, and a shift beyond outcomes to *aptitudes* (Section 1.2).

- ***Feed-forward:*** There is currently no mechanism for passing feedback on to strategy, to inform traffic models, patronage data, or other factors associated with planning. Newig et al. (2010) too, highlight the need for learning at the level of network governance rather than actor level.
- ***Follow-through:*** Similarly, there is no process for capturing the multiple layers of benefits as they emerge within the project, and to follow the threads through both the organisation and the lifecycle. This needs to transcend organisational, functional, personal, and other boundaries. The impacts of this were seen through the assessment of cOPEX (Chapter 6).

5.3.4 Influencing change

Auckland Transport provided some initial reflections on the research and actions and/or issues that might be required to effect positive change stemming from the findings (see Appendix VI, Section AVI.4). Themes of particular note were:

- ***People:*** Shaped around perceptions/beliefs and the need to re-orient the organisation.

- ***Operational costs:*** Highlights the concern with the implications of actually delivering all of the benefits attached to both the current system and new projects (‘doing everything we said we would’), and the ramifications for wider practice.
- ***Accountability:*** The workshop showed that change does not rest within one part of the organisation (or indeed only within the study organisation itself). But it was not clear which part of the organisation would own the process, or ensure the various ‘threads’ had been followed through. Personal accountability was seen as being central to the ability to effect change to the system and current practice, and underpinning, more generally, the change network that had been drawn.

5.4 Detailed study 1 discussion

5.4.1 System-level benefit realisation

There are a number of mechanisms available for managing benefits, whether as part of a specific benefit realisation framework, or general asset or project management guidance. However, the dynamic, and non-linear nature of infrastructure as a system, means that these are unlikely to be sufficient on their own. This is because they target one part of the infrastructure lifecycle, and this is reinforced by organisational structure and other decision-boundaries.

What has been shown by the examples provided within Appendix VI, and can be deduced from this study, is that benefits need to be understood and managed at a variety of levels that reflects organisational structure and function, customer need/system objectives, discipline, and timescale (amongst others). Furthermore, whilst various tools may be useful in managing discrete packages or projects, they may actually reinforce system-level disconnects by suggesting a sufficiency rather than continuum of outcome. Moreover, they may do so from a singular perspective that may not necessarily capture or reconcile all requirements.

The preliminary research revealed four dimensions that affect how long-term infrastructure outcomes are understood: needs, precepts, choices, and aptitudes (Section 3.2). These dimensions envelop matters that enrich benefit complexity, such as value delivery (Basole & Rouse, 2008; Liyanage & Kumar, 2003). Benefits also need to extend beyond merely society's interaction with infrastructure assets (how it uses the infrastructure) to what the infrastructure enables (Chapter 7). Consequently, infrastructure requires particular care to orient benefits towards the communities it is being designed to serve. In the transport sector, for example, the movement of things should not be conflated with the movement of people, just as congestion should not always be construed as need.

As a new organisation, Auckland Transport has had the opportunity to re-establish strategy and orient the organisation towards benefit delivery. So it also has the opportunity to avoid the default 'coping strategies' identified by Johnston and Pongatichat (2008).[84] However, the focus on maintaining the delivery of projects has resulted in the misalignment of strategic documents in several areas, and the strategic intent becoming tactical. Whilst the programme and project prioritisation framework has been a major and necessary initiative, in this context it reinforces the project-oriented focus. These factors contribute to a situation whereby benefits are neither highly visible nor transparent at the governance level of the organisation. This in turn amplifies the absence of benefit management at the project-level and the failure to feedback into strategy. Again, the preliminary research interviews indicate that Auckland Transport is not alone.

For infrastructure management to better align with strategic intent, of vital importance is another level of benefit management aimed at the whole of the organisation, the infrastructure system, and the progressive and continually evolving outcomes it is seeking to achieve. This is not simply a matter of applying existing tools and frameworks to the organisation as a whole (but they may help). This study has also identified multiple actions and areas where improvements can be made (see Appendix VI), but many of these will be specific to the subject organisation at the very detailed level.

Beyond this, it would appear that there would be merit in purposeful system stewardship. Zimmerman and Sparrow (1997) describe stewardship as "*a*

[84] See Section 1.2.

collective sense of ownership or accountability", and the concept is described by Senge (2006) as a paradox akin to that of evolution: "*a process of "transformation through conservation*"".

Figure 5.1 indicates where this function might sit within a generic infrastructure administration structure (potentially introducing the role of 'system steward' to better define accountabilities). The introduction of system stewardship into the operating model, as well as its integration within the organisational culture or 'mode', should assist in redirecting governance towards operations and system-level outcomes. It also has the potential to establish system-level operations as the basis through which projects, if any, are defined. This is indicated in Figure 5.1 by the increased emphasis given to the governance–stewardship–operational relationship. As such, this offers an alternative to the current, project-oriented paradigm (Chapter 3).

System stewardship is not proposed as another layer of bureaucracy. Rather, the key to this operating model and mode is that:

- The organisational model is operationally oriented towards the system and its long-term outcomes by emphasising the function of the existing system and its operation. This is a move away from the current project dominance and is aimed at emphasising the role projects have in transforming the system (proposition 1). This also provides for the resolution of divergent commitments, objectives and resources (Doz & Kosonen, 2014), and the incremental development of strategy (Thiry & Deguire, 2007).
- System stewardship provides a governance interface by synthesising feedback so that this may be integrated within strategy and governance-level decision-making. This provides for the loss of co-ordinating roles (e.g. Borough Engineer), and is aimed at developing "system fitness" (see propositions 1-3).
- There is greater accountability within the system. Operations must define, and capital development must follow-through on project outcomes and benefits.
- Operational divisions are oriented away from functional boundaries and focused upon integrated long-term, service outcomes.

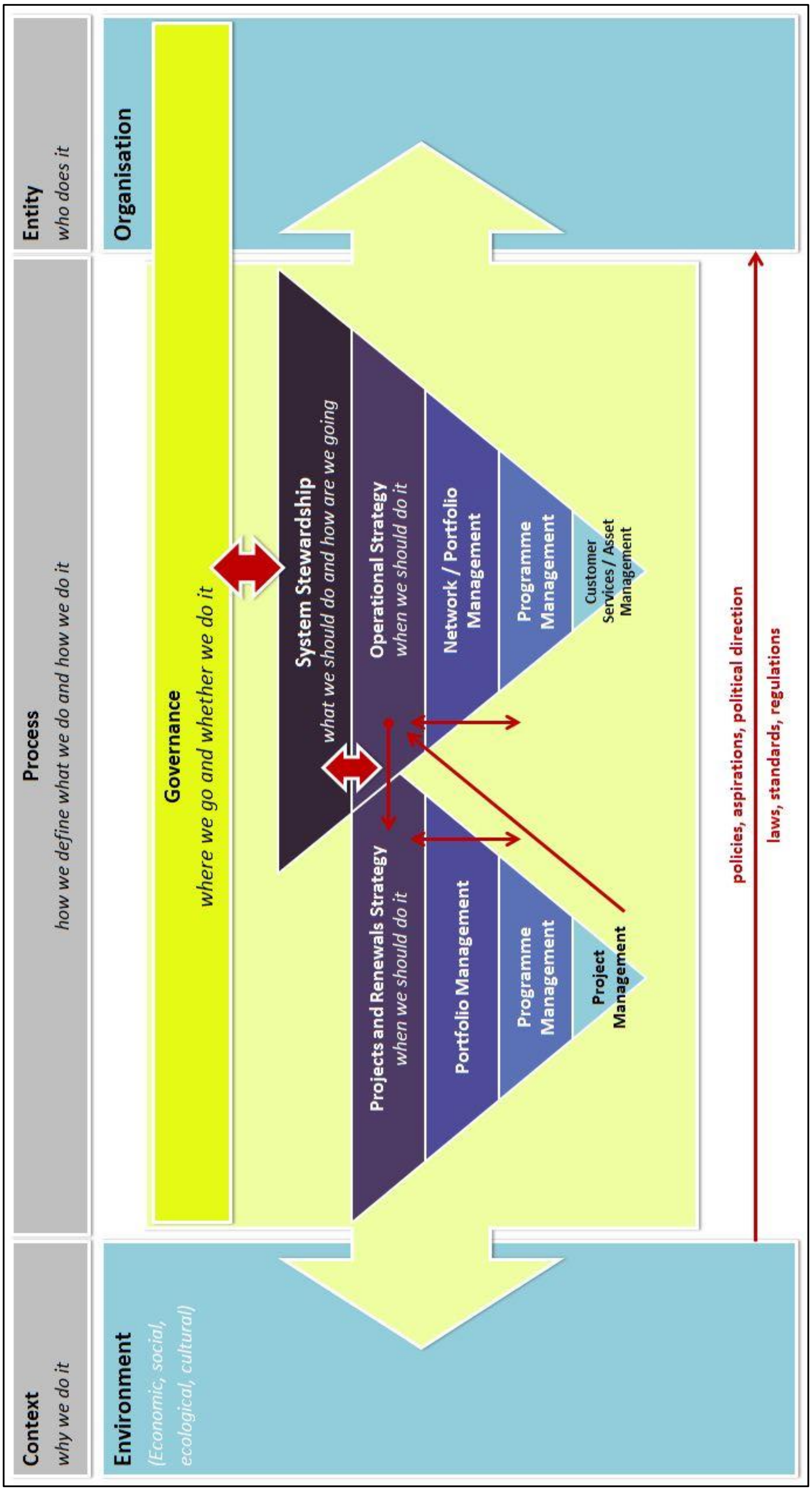


Figure 5.1: System stewardship model

The notion of system stewardship is not new — at least in New Zealand where it has cultural roots in the principle of kaitiakitanga,[85] and has since been enshrined in the RMA (1991). Whilst in the 1990s Dunning noted that public sector organisations were "*the only agent to have broad social system stewardship responsibilities*" (in Doz & Kosonen, 2014, p. 8), the concept seems only more recently to have been gaining traction, mainly within the healthcare sector (e.g. Alvarez-Rosete, Hawkins, & Parkhurst, 2013; Majdzadeh, Yazdizadeh, Nedjat, Gholami, & Ahghari, 2012).[86] It is also supported by Hallsworth (2012, p. 11; as introduced by Nash), in the field of 'new economic thinking' (emphasis added):

> *Government institutions, law makers and civil servants could learn a lot from complexity science. While the broad trend in government over the years has been to approach ever more complex challenges by 'a more sophisticated application of traditional, linear thinking, such as more analysis and evidence reviews, more detailed strategies and plans, more rigorous performance monitoring', this has had limited success. An appreciation of complex adaptive systems would* [...] *overcome the policy inertia that results from rigid, preformed plans, as well as generating greater feedback and learning. It would also ensure that complex, cross-cutting challenges were dealt with in a system-wide manner, rather than by isolated central government departments.* ***Such 'system stewardship' would*** *[...]* ***significantly improve strategies for governing.***

Whilst the need to integrate benefits at the system level might seem self-evident, this is not a concept that currently appears widely within the literature associated

85 "*Guardianship, stewardship, trusteeship*" ("Maori dictionary," 2003-2016).

86 McArthur (2012) has explored public sector stewardship more generally and also notes the cultural context of the term. This cultural context is important, and it would therefore be appropriate for the meaning of stewardship be refined within a local context. That does not change the broad intent of system stewardship being proposed here.

with the 'hard' infrastructure sectors.[87] Moreover, industry-wide interviews suggest this is also not prevalent within practice.[88]

Without proactive and purposeful system stewardship, infrastructure benefits are unlikely to be realised over the long term (proposition 2). The establishment of a system stewardship function provides a mechanism to enable strategic agility and adaptive capacity. It should also evoke the story telling necessary to augment the management of a complex adaptive system over time (Boal & Schultz, 2007; Doz & Kosonen, 2014; Snowden, 2003).

5.4.2 Wider industry relevance

This study is, by its very nature, organisation-specific in its detail (and not generalisable at that level). However, comparison of the commentary from the wider, international industry (Chapter 3) points to shared high-level concerns and issues (Appendix IV). Where opinions differed, these tended to be in the category of 'could do better', or a 'work in progress', and in the minority.

One of the interesting aspects to be commented on within the wider interviews,[89] related to the role of 'unrelated' organisational processes such as the personal performance and development measures stemming from human resources. This is broadly on the same continuum as the measures of success for project managers; however, whilst a project manager might be an external provider, in-house performance measures can be more difficult to unpick and reorient. This thread was explored in more detail with a human resources specialist from the infrastructure sector. They acknowledged that linking career development to specific tasks in this way had created issues in the past, and whilst the practice was changing, still had some way to go ([PR59]). It would therefore appear that just as

[87] Although there is limited high-level recognition of the need for infrastructure stewardship (e.g. IPENZ (2010); Zimmerman and Sparrow (1997).

[88] e.g. [PR15-PR16], [PR18-PR19]. [PR22], [PR24], [PR26-PR28], [PR30-PR33], [PR37], [PR42], [PR44-PR45], [PR47], [PR50], [PR53], [PR58], [PR60], [PR63], [PR66].

[89] [PR16], [PR65].

study 2 recommended financial practice change to better enable long-term infrastructure outcomes, other support areas such as human resources also need adjustment to better align these to the public administration of infrastructure. This, of course is not new (e.g. Box, 1999; Metcalfe, 1993), but given the observations from within industry, it is yet to be fully resolved (see also Doz & Kosonen, 2014).

5.5 Detailed study 1 conclusions

This study has explored benefit management across the strategy–project interface using mechanisms aimed at different aspects of this interface: the connectivity of the strategic framework, benefit visibility at board level, and project-level benefit delivery. A summary of the key points from the deep dive are provided within Table 5.1.

Table 5.1: Summary of the benefit management deep dive

Strategy—project transition: System benefits management (Auckland Transport)	
How is the misalignment being generated (what are the reasons for the misalignment)?	
Strategic Mapping	▪ Homogeneity: dominance by assets and projects. ▪ Document (strategy) development order. ▪ Poor iteration/change management. ▪ New strategies/measures as a response to problems. ▪ Ability to understand, connect and align all parts of the system.
Benefit visibility	▪ Dominance by features (outputs). ▪ Lack of system-level benefit visibility. ▪ Disconnect between strategic intent and project benefits. ▪ Reported follow-through and feedback non-existent. ▪ Unclear how teams act on others/strategic intent.
Project-level benefit management	▪ Under development/emergent. ▪ Focused on project not system. ▪ Dominated by tipping points from BCR (e.g. traffic). ▪ Lack of disbenefit management.

Strategy—project transition: System benefits management (Auckland Transport)	
	▪ Deferred benefits — over-claimed system benefits. ▪ No feedback, feed-forward, or follow-through.
Synthesis[90]	▪ Dynamics of system not managed. ▪ Benefits not understood at multiple dimensions (scale, customer, function, timescale etc.). ▪ Embedded misalignment through incremental change. ▪ Wider corporate practice (e.g. HR/personal performance requirements) can also impede.
Effects	
▪ Absence of service-related strategy (and outcomes). ▪ Loss of connectivity and transparency. ▪ Complicated framework — proliferation of requirements. ▪ Unclear how individuals, teams etc. contribute (counterproductive/silos). ▪ Loss of knowledge/reduced capacity for organisational learning. ▪ Red-queen busyness with unknown progress/benefits not visible. ▪ Loss of customer voice. ▪ Loss of outcomes (simplification, homogeneity of customer/function/service). ▪ Movement of things misconstrued as movement of people (technical vs service outcomes). ▪ Does not support strategic intent.	
Implications and interventions	
▪ Project-level benefit management is not enough — benefits must also be managed at system level. ▪ System stewardship required: System-level synthesis/management of multiple benefits and multi-dimension benefits plus system dynamics.	

[90] Because this detailed study involved three separate stages and methods, as described in the methodology, it involved its own cross-case analysis and synthesis. This does not, therefore, appear within the equivalent tables for the other detailed studies.

Strategy—project transition: System benefits management (Auckland Transport)
▪ Deferred benefits need to be understood and managed.
▪ Corporate process (e.g. HR) also needs to align to outcomes.
▪ Detailed interventions per specifics of case/organisation.

The study shows that whilst theoretical frameworks are likely to be useful, these are bounded approaches that do not necessarily assist the organisation in aligning the benefits with a strategic context that is dynamic, and which should be system-focused and externally-oriented. Furthermore, the organisation needs to actively anticipate feedback, feed-forward and follow-through from the tactical delivery of operations and capital development to enable any benefit management or realisation 'scheme' to have any real meaning or traction.

It is clear from this study that system-level co-ordination and integration is being lost within the 'tactical strategy' of programmes and initiatives. As a consequence, this is creating a 'red queen'-like busyness without any real understanding of whether anything has been achieved relative to the intended or necessary outcomes being sought. The notion of system stewardship has therefore been advanced. Whilst this is not a new concept, it has only recently appeared within the health sector and is novel within hard (built) infrastructure. Moreover, it appears to be an appropriate response to system-level complexity and a potential enabler of strategic agility and adaptive capacity.

6 DETAILED STUDY 2

WHOLE-OF-LIFE MANAGEMENT

The previous detailed study has identified issues in the strategy–project interface that disrupt the ability to align infrastructure management practice with its strategic intent. This second of the three detailed studies now investigates the project to operations interface of the infrastructure lifecycle, being the second of three processes to span key lifecycle interfaces or transitions (Tables 2.1 and 4.1). Like the first study, it is aimed at providing clues or analogies to develop an understanding of the issues. The material, in turn, provides the evidence-base and inputs for the subsequent cross-case analysis that is to follow within Part III.

Brief description: Post project delivery, operational estimating of the cOPEX arising from new projects and programmes.

Strategic intent: Auckland Transport, as a Council Controlled Organisation, is charged with aligning with the wider plan objectives (strategic intent) of the Auckland Plan (Auckland Council, 2012a) and specifically the delivery of Auckland Council's transport related objectives. The organisation delivers projects within this context, and in so doing, articulates project-level objectives and intended system-level benefits which it expects to be delivered.

Contributing factors investigated (see Table 3.1):

- Handover (feed-forward).
- Transition from asset to system.
- Whole-of-life performance.

Organisation: Auckland Transport (local government organisation).

This study explores the project–operations interface through a detailed assessment of consequential operating expenditure (cOPEX). cOPEX is the new maintenance and operational expenditure arising from capital development and is a subset of total OPEX. It includes the maintenance of assets at nominated or defined levels of service, plus any associated management, compliance, and service costs (such as public transport services in the case of transportation infrastructure).

Although there are requirements to undertake whole-of–life cost assessments as part of capital development, issues with the forecasting of cOPEX have been found in New Zealand local government (Controller and Auditor-General, 2014a). Given the extent and complexity of Auckland Transport's forward works programme, its cOPEX has been identified as a significant issue for the city. The issue is currently understood by Auckland Transport to be more than a matter of simply applying existing theory; however, the scope and materiality of the issues are not well understood.

6.1 Introduction to consequential OPEX

Auckland Transport is again the focus of this study. Its wider regional and sector context is described in Appendix I.

Auckland Transport has estimated NZ$60B[76] of capital expenditure and investment (CAPEX) over the next three decades (Auckland Transport, 2013a), with a short-term annual capital works budget of NZ$600M–NZ$650M excluding renewals (Auckland Transport, 2014d). NZ$1.86B over the next 10 years has been provided for *"network maintenance and asset operations*". In this context, this means the maintenance of the local road network, and transport-related assets such as public transport facilities and commuter rail depots and rolling stock, but excludes the provision of transportation services, or maintenance of the wider rail and State highway networks. Notwithstanding any limitations with the current approach to estimating OPEX, this excludes growth, the current renewals programme, and the "*increased requirement for maintenance that will arise from the reduced level of renewal investment from 2019 onwards*" (Auckland Transport, 2015b). Auckland Transport (Ibid.) estimates the additional 1.5% of asset growth will result in an annual cOPEX of NZ$2M, bringing the total OPEX to NZ$119M over a ten year period, just to stay apace of the growth in assets. Yet (Auckland Transport, 2014b, p. 1; emphasis added):

> *Historically, there has been little, if any, coupling between the capital development programme and the increases to maintenance and operational costs. CAPEX and OPEX budgets are mainly viewed and managed in isolation.* ***There is little visibility or reporting around the consequential OPEX implications of capital development at a board or executive leadership level.***
>
> *Whilst operational budgets have been increased to allow for growth, this has largely been on the basis of a simple percentage uplift. Historically this has been in the range 0.8% to 2.5%* [of the existing operational budget], *with the level mainly influenced by budget pressures or linked to population increase.*
>
> *This formulaic approach does not accurately reflect the increasing pressure on operational and maintenance budgets arising from:*
>
> 1. *The growing influence of amenity and urban design considerations in infrastructure design*
> 2. *The increasing use of non-standard materials and fittings*
> 3. *Increasing network complexity and interrelationships.*

Not surprisingly, Auckland Council (Auckland Transport's sole shareholder) also considers the impact of "*consequential OPEX*" to be a key issue at this time (Auckland Council, 2012b). But Auckland is not alone. As part of a review of all New Zealand local authorities' audited financial statements, and the long-term plans and asset management information for 31 local authorities, the Controller and Auditor-General (2014b, p. 17) found that:

> *When local authorities forecast their spending, they typically base their forecasts on assumptions about* […amongst other things, the] *consequential effects on operating expenditure of the forecast capital additions.*

However, there is a perception that cOPEX is minor and so does not warrant detailed evaluation: in considering the drivers of New Zealand local government expenditure in New Zealand, GHD (2007, p. 24) was of the view that:

> *One would expect that for transport, capex has a small influence on opex because usually a capex project is a relatively small part of an extensive transport network and opex costs occur 10-15 years later — apart from debt servicing.*

Yet such issues are not limited to the New Zealand local government or transportation sectors. For example, in the preliminary research (Chapter 3), it was found that the underlying operational system rarely adjusts to accommodate changes arising from the delivery of a new project (e.g. changes to maintenance or other specifications/contracts and/or delivery of additional projects or changes to assets or services).

The *Green Book* (HM Treasury, 2011, p. 29) also observes that:

> *Many project parameters are affected by optimism — appraisers tend to overstate benefits, and understate timings and costs, both capital and operational.*

However, optimism bias (as it is known) is a slightly different matter from the focus here, as it relates to project and investment decision-making in the first instance. The cited incidence of OPEX underestimating (Ibid.), coupled with the use of cOPEX forecasts (Controller and Auditor-General, 2014a), suggests that the theoretical handover of operational schedules prepared during the project delivery stage is not occurring and/or these are not being used by, or have relevance to, the operational division(s) of an infrastructure organisation.

This research responds to this problem by providing an in-depth analysis of the cOPEX of a complex, multi-modal transportation programme. Rather than the usual project or asset management approaches, the research instead adopts a whole-of-organisation, and system-oriented perspective. Interviews from the preliminary research (Chapter 3) were also used to augment the study and test its broader applicability. The focus of the study is how OPEX arising from new project

CAPEX has been estimated by the operational divisions of an infrastructure provider, and the implications that this has for long-term infrastructure outcomes.

6.1.1 Definitions and current conventions

OPEX is typically defined as, and understood to be, operational expenditure/operations expenses (e.g. Audit New Zealand, 2010; Greffioz, Olver, & Schirmer, 1993; Lantz, 2013; Van Themsche, 2016). Simply put, it includes all costs required to provide services (e.g. public transport), and to operate and maintain assets at defined levels of service over the long term at an asset, network, and systems level. Also included are "*costs for operations personnel, materials, fuel, chemicals and energy consumption*" (National Asset Management Support (NAMS) in Audit New Zealand, 2010). Some costs may derive from new capital expenditure (CAPEX), and this has been termed 'consequential OPEX' (cOPEX) to reflect current industry use (e.g. Auckland Council, 2012b; Auckland Transport, 2014b; and to paraphrase, Controller and Auditor-General, 2014a). The term has been adopted by infrastructure practitioners as a shorthand way of defining new project operational costs as a subset of the wider OPEX budget, and to distinguish the estimate from any of those prepared as part of project development or delivery.

With such an all-encompassing but clear definition, it might be supposed that understanding OPEX, and more so cOPEX, is relatively straightforward. Unfortunately this does not appear to be supported by either literature or industry practice. Indeed the literature is rather sparse in advancing matters much beyond the generic definition. However:

- Greffioz et al. (1993) identify three commonly used methods for assessing OPEX for oil and gas production facilities: the use of multiplication factors applied to CAPEX, the use of spreadsheets, and "*ad hoc comparisons with previously estimated or known costs for other similar plants*".
- HM Treasury (2011, pp. 29-30) states that:

  Sensitivity analysis should be used to test assumptions about operating costs and expected benefits.

  Adjustments should be empirically based, (e.g. using data from past projects or similar projects elsewhere), and adjusted for the unique *characteristics of the project in hand. Cross-departmental guidance for generic project categories is available, and should be used in the absence of more specific evidence. But if departments or agencies have a more robust evidence base for cost overruns and other instances of bias, this evidence should be used in preference. When such information is not available, departments are encouraged to collect data to inform their estimates of optimism, and in the meantime use the available data that best fits the case in hand.*

Asset management practice also includes consideration of operational cost as the following definitions demonstrate (NAMS, 2011):

- Asset management: "*The systematic and coordinated activities and practices of an organisation to optimally and sustainably deliver on its objectives through the cost-effective lifecycle management of assets*."
- Lifecycle cost: "*The total cost of an asset throughout its life including planning, design, construction, acquisition, operation, maintenance, rehabilitation and disposal costs.*"

ISO (2014a, 2014b) is less specific, with 'lifecycle' being simply the "*stages involved in the management of an asse*t", and noting that "*the naming and number of stages and the activities under each stage usually varies in different industry sectors and are determined by the organisation*". However, similar definitions to those used by NAMS may be found in other asset management guidance (e.g. The Institute of Asset Management, 2008).

Some might perceive asset management to therefore be sufficient (Chapter 3). However, there are several issues with such an assumption:

- OPEX is not limited to hard infrastructure and assets; and
- asset management processes and tools:
  - often have gaps in asset capture and data reliability issues (Controller and Auditor-General, 2014b, p. 30; GHD, 2015); and
  - may have been developed for linear assets (such as those within a road corridor), so may not be suitable for non-linear and/or complex assets such as public transport facilities, parking, town centres, and 'blue-green'

infrastructure such as wetland ponds and rain gardens (e.g. Blom, Irwin, & Rangamuwa, 2011).

Furthermore, areas of asset management practice should not be confused with the ability (or need) to develop an appropriate operational budget, or be misconstrued as necessarily providing for all organisational needs.

Projects delivered by Auckland Transport, are partially funded through a land transport fund administered by the NZTA. As a consequence, NZTA funding requirements and guidance documents are relevant to, and have an influence on current practice (e.g. NZTA, 2010; NZTA, 2013a, 2013d). Unfortunately, any discussion of whole-of-life costs and cOPEX within NZTA guidance is also limited, and may in fact result in perverse outcomes. For example the NZTA Cost Estimation Manual (NZTA, 2010), defines ‘whole of life’ as the period from project investigation and reporting through to the end of construction (and such an assessment was undertaken for the programme of works discussed later). This is not necessarily inconsistent with wider practice. ISO (2011), for example, describes lifecycle costing as a “*methodology for systematic economic evaluation of life-cycle costs over a period of analysis,* ***as defined in the agreed scope***” (emphasis added).

So whilst there may be a perception that cOPEX is, or should also be covered within a whole-of-life assessment, as this shows, a lifecycle assessment does not necessarily provide for everything. There is, therefore, a good possibility that there will be miscommunication around the term ‘whole-of-life’ assessment, with the meaning ‘lost in translation’.

Where a whole-of-life assessment is undertaken as part of a project business case or investment decision, any sensitivity analysis and/or long-term implications may also be obscured by the use of discount factors. Yet from an operator’s perspective, discount factors do not apply. Indeed, OPEX figures need to be inflation adjusted. As long-term expenditure is not static and needs to respond and adapt to an evolving asset condition, levels of service, and context, there is a need to address cOPEX for operational needs. This requires a whole-of-organisation, and a system-oriented approach.

Whilst Dobbs et al. (2013) have observed that there are significant opportunities to optimise infrastructure maintenance and operational practice, they do note that the first step in this is to assess and catalogue needs. The New Zealand Controller and Auditor-General (2014b, p. 6) appears to concur:

> *Spending according to budget is only sensible and appropriate if the budget is likely to be a good guide of what should be spent.*

Such a basic and perhaps obvious step of firstly understanding what is required appears not to have received the attention it should. After all, *"if you rely on something, you need to recognise it and manage it over the long term*" (Ibid., p.4).

6.1.2 Detailed study 2 context

In the preliminary research, practitioners were asked whether competence was a factor. Whilst it would be easy to summarily dismiss issues (such as those identified here) for this reason, it was found that it was not so simple (Chapter 3). So for completeness and context: New Zealand has had a strong reputation in public sector reform (Hood & Peters, 2004; Sehested, 2002; The World Bank, 1998), and thence Asset Management, particularly in road infrastructure (Aikman & Doherty, 2006; Federal Highways Administration, 2005; and NAMS, 2011 (which is referenced in the ISO 55000 series, 2014)). Preceding amalgamation, local government in the Auckland region had also previously contributed examples of good asset management practice to industry guidance (e.g. Audit New Zealand, 2010).

Current Auckland Transport practice

Auckland Transport has advised that cOPEX is currently assessed at the 'programme' level rather than on an individual project basis, as follows (Auckland Transport, 2014b, p. 5):

> 1. *Identify the individual asset classes created by each project included in the capital new work programme.*

2. *Establish the level of growth (the increase in the quantity of the asset) for each asset class using a representative sample of projects.*
3. *Assess the annual increase for each asset class using the ratio of the value of the new assets being created to the aggregated replacement value for that asset class.*
4. *Apply the ratio calculated to the operational budget for that asset class.*

The organisation is aware of the shortcomings of this approach, and is working on the development of a more robust method. This study is understood to be informing that process, so at the detailed level also provides an example of the application of Systems Thinking to Action Research (Flood, 2010).

Compliance context

In Campbell, Jardine, and McGlynn (2011), legal compliance and the environment are two of five identified 'hidden' operational costs. However, this misses the point: legal compliance is mandatory. Costs should therefore be identifiable by association with known actions and requirements.

Notably, in New Zealand, the RMA (1991), provides the statutory framework for the sustainable management of natural and physical resources (Appendix I). The Act includes criminal liabilities and significant fines for offences against the Act (Ibid.), underlining both the compulsion and the significance of understanding and implementing operational compliance requirements. AMETI, which is again used for this detailed study, required several authorisations under the RMA, which have conditions to avoid, remedy, or mitigate adverse effects, and which include long-term requirements.

6.2 Detailed study 2 methods

This detailed study again uses the AMETI programme (Chapter 5/Appendix V). The methodology investigates cOPEX from across the infrastructure lifecycle and across the study organisation. This can therefore be viewed as a series of studies that look at a single project through different lifecycle perspectives. Chapter 5 gives the rationale for the choice of AMETI as a single case within this detailed study.

Assessment of consequential OPEX

The main task comprised a review of available project documentation to enable the development of a cOPEX schedule from first principles, but with reference to existing contracts and the organisation's Asset Management Plan (Auckland Transport, 2015b).[91] Where costs were available from previous estimates, these were added to the schedule. The schedule was then provided to Auckland Transport to cost, and compared with other recent estimates of cOPEX as well as a high-level comparison with other projects. The final phase of the process included meetings and a workshop.[92] The workshop included a line by line analysis of key worksheets within the schedule, drawing on Auckland Transport's maintenance and asset cost database where possible.

Although Auckland Transport involved multiple parts of its organisation in the estimating process, the schedule could only be partially populated. Some costs, such as road markings, could be estimated to the nearest dollar. Whereas the costs for areas such as compliance and structures were largely absent. The organisation concluded it would need to outsource the estimating to complete the schedule. In short, basic operational requirements were not readily available or understood, and this was affecting the scope of ongoing operational actions.

For completeness, it is noted that whilst operational *revenues* are important, the focus of this research is upon operational *expenditure* from the perspective of the day-to-day organisational operations. The study therefore does not revisit the whole-of-life assessment or BCR calculated as part of the initial programme investment decision-making. Similarly, whilst procurement routes may purport to offer different operational outcomes, there is still a need to investigate this area —

[91] Approximately 128 project reports/documents were available and reviewed within the study period.

[92] Refer to Appendix II (Section AII.2).

at least within the New Zealand setting — where infrastructure is largely in public ownership, and public-private-partnerships used selectively.

Assessment of wider issues

As the cOPEX schedule was compiled, key issues to emerge from the project documentation were also grouped into thematic clusters for further consideration by 'cutting and sorting' (Ryan & Bernard, 2003). The process was augmented by the additional sources cited in Chapter 5. Extracts from the source material provide examples/evidence, but only some are included for brevity.

Influencing change

The wider matters were then reassessed to identify connections between themes to generate a network map of the linkages and connections (using social network mapping/graphing programme Gephi). The purpose of this step was to produce a visual, rather than just a descriptive, picture of the system-level matters to be addressed, and to enable the 'communities' of change and possible implications to be understood. To augment this, a short (one hour) workshop was held with two senior Auckland Transport specialists (September 2016), with the purpose of focusing this further and to canvass the range of matters that would need to be changed or addressed in response to this study (see Appendix II). The issues were captured by the Auckland Transport workshop participants on a whiteboard as a mind map. The workshop output was then replotted using Gephi networking software, which enabled the relative connectivity of issues/actions to be highlighted, establishing a hierarchy to assist the organisation prioritise its response.

The outputs could inform and help the organisation to prioritise change, as highly connected points are likely to create 'leverage' or to have a disproportionate effect upon the system. To this end, the workshop also served as a consciousness raising exercise and 'socialised' the issues and concepts. Whilst Auckland Transport has advised changes have arisen already as a consequence of this work (Section 9.2.2), implementing any change is not part of the scope of this research (Chapter 4).

6.3 Detailed study 2 results

Because the calculation of the cOPEX is so fundamental to the discussion that ensues, this short section has been retained within the body of the thesis. The detailed assessment of the wider implications arising from the study, together with the assessment of influencing change, are found in Appendix VII. For completeness, a brief summary of both is also provided within the sections to follow.

6.3.1 Assessment of consequential OPEX

The revised schedule of cOPEX enabled the reassessed costs (termed the ‘amended cOPEX’) to be compared with other estimates (Table 6.1). These cover the generic methods outlined by Greffioz et al. (1993) and HM Treasury (2011) as described previously (Section 6.1.1). The amended cOPEX schedule identified a wide range of matters that other estimating techniques used by Auckland Transport had failed to identify. However, only some of these were able to have costs determined. Accordingly, the amended cOPEX figures still exclude a significant number of cost items that were also missing from other estimates, such as (but not limited to):

- The cost of completing the project or rectifying issues (e.g. completion of stormwater treatment and related amenity requirements). These are considered to be CAPEX but remain outstanding costs to the organisation.
- The incremental cost to general overheads (i.e. if the project requires less than one full time equivalent for any one role). These were seen as the ‘cost of doing business’ but included a substantial scope and list of un-costed activities/resource requirements.
- Variations to existing maintenance/operational contracts: these would not be ‘seen’ within the estimate until retendering of the associated contract.

Table 6.1: Comparison of consequential OPEX

Estimating method	Estimate (NZ$M)	Comments	% change: prorated cOPEX (*approx.*)
Actual	Not available	Costs for first year of operations. Actual costs not specifically tracked and not readily identifiable. <1% of the 'total amended cOPEX' could be traced.	Not available
Prorated	$2.15M/y	Current estimating method. Assumes OPEX is a percentage of CAPEX. No rate was available for the tunnel and NZ$167.51M CAPEX had no OPEX in the previous 'estimated cOPEX' exercise. To provide a minimum figure, the lesser road rate was applied to the unassessed CAPEX.*	0%
Estimated	$1.26M/y	Recent asset-led estimation. This uses rates sourced from Auckland Transport, maintenance contractors, and benchmarks from other similar assets or facilities.	60%
Amended	$2.49M/y ($7.49M/y)	This study. Excluding public transport services, most compliance actions, and tunnel and major structures maintenance costs. Including additional bus services (known within subject organisation but not included in previous OPEX estimates). See exclusions (above).	115% (350%)
Additional costs	$1.06M	*Additional one-off costs able to be readily identified. Includes estimated cost of resolving archaeology, opportunity cost from resale of contaminated land, and emergency and operational training associated with the new tunnel.*	

**The CAPEX:OPEX ratio arising from the estimated cOPEX was comparable to the ratios assumed in the prorated estimate. By contrast the CAPEX:OPEX ratio arising from this exercise was typically greater (sometimes significantly so). If relatively minor changes were made to the prorated figures using the lower of the assessed ratios, then the recalculated prorated annual OPEX would be in the order of NZ$3.1M (i.e. +40% of current/prorated and +145% of the*

Continued from Table 6.1:

estimated cOPEX figures). In a study of public transport growth for Auckland, Deloitte (2013) note that the OPEX:CAPEX ratio used in their assessment also excludes any consideration of additional public transport services to accommodate growth. That ratio, whilst slightly higher than the rate used in this study to calculate a prorated value for the road-related assets, is significantly less than that for the stations.

Note: The overall accuracy of the amended cOPEX cannot be assessed given the scope of outstanding omissions. However, it is considered that the amended cOPEX is a minimum value. A list of the more substantive omissions and unknowns are given in the body of the text.

- Longer-term costs, particularly assets such as significant structures that have increased maintenance requirements and costs towards the end of their design life. There is no current framework for estimating these and then accounting for the costs that will eventually be incurred, but which is currently outside the budgetary cycle of three years or the long-term estimating period of 30 years.
- Costs that are too difficult to readily break down to the project level (e.g. finance, insurance) or to cost (e.g. the cost of changing context or technology, natural disasters, risk). These include costs that could not be assessed as requirements could not be identified (e.g. because some of the required management plans have not been delivered), together with ongoing programmes to help the system evolve (such as network optimisation).

This exercise has not added new requirements. Rather, it captured undertakings made within design reports or required within consent and other approvals-related documents and authorisations, all of which would have been subject to sign off as part of project development and delivery. However, these can be 'lost to the system' when project records are archived at the end of the project delivery phase.

Comparison of schedule scope, let alone the costs, highlights a significant number of requirements for which costs have not been previously assessed. Indeed operational personnel indicate that they were not even aware of many of the ongoing requirements. Although not the sole reason, there is a danger that without budgetary prompting, operational requirements get overlooked. Ackoff (2006, p. 706) offers an apposite observation in this regard:

> *Accounting systems in the western world only take account of errors of commission, the less important of the two types of error. They take no*

> *account of errors of omission. Therefore, an organization that frowns on mistakes and in which only errors of commission are identified, a manager only has to be concerned about doing something that should not have been done. Because errors of omission are not recorded they often go unacknowledged. If acknowledged, accountability for them is seldom made explicit.*

The implications of course go beyond simple accounting practice, as this affects what 'gets done' and in the case of compliance or social and environmental outcomes, what costs (and/or effects) are ultimately externalised.[93] Flyvbjerg, Holm, and Buhl (2002, p. 288) also touch on this point, but in relation to project delivery, where they assert "*Project promoters and forecasters may deliberately underestimate costs in order to provide public officials with an incentive to cut costs and thereby to save the public's money*". The effect of such practice is to disincentivise the inclusion or consideration of cOPEX early within project delivery process lest this affect the business case. The absence of feedback within the process (Flyvbjerg, Skamris Holm, et al., 2003) is such that project managers are unlikely, in any event, to be held to account for any OPEX estimated during this phase.

This exercise has shown significant adjustments need to be made to cOPEX estimating practice, and that OPEX:CAPEX ratios can be misleading. However whilst the percentage change is significant, an annual increase of $1.23M over previous estimates (or even $6.23M with the new public transport services included) may not be seen as significant when considered in the context of the operating budget as a whole (approximately $186M annually). The 'known' or 'identifiable' impact of the first stage of AMETI alone, with a CAPEX of NZ$215M is approximately 5% inclusive of public transport services, or if these are still to be reported in a separate budget, then by approximately 1%.

[93] This may also be an indirect effect when unscheduled/unplanned consequential costs redirect budgets from other areas and/or affects levels of service.

However, the total AMETI programme has an estimated CAPEX of NZ$1.16B. Setting aside the additional public transport services for the time being, if the same issues are replicated across the remainder of the AMETI programme (which is reasonable to expect), this will have an impact on the Auckland Transport's OPEX budgets by approximately 5% (even with the extensive estimating limitations). However, if just the Stage 1 'additional costs' (Table 6.1) are added to an amended cOPEX figure for the whole AMETI programme, the impact on the overall annual organisational OPEX is approximately 10%, and challenges the assumption that CAPEX does not significantly affect OPEX in transportation (see GHD, 2007). There is then an obvious question as to whether similar 'discrepancies' exist across the organisation and other projects or programmes. The organisation itself considers the AMETI to be an indicative programme and of a scale to test a large number of organisational processes and practice.

Another counterpoint to the possible perception this might be an inconsequential 'error' is that the cost of actually completing all of the tasks originally proposed — thereby enabling the delivery of the envisaged project benefits (compliance, sound engineering, function/social/system outcome, reputation) — is relatively small. The additional CAPEX to address system shortfalls, by contrast, is more significant and therefore presents an opportunity cost to the organisation. The impact of opportunity cost, such as other projects not being delivered or reduced levels of service, has not specifically been assessed through this exercise and remains an area for further study.

6.3.2 Assessment of wider issues

The reassessment of the cOPEX estimate should enable improvements to the estimating process by identifying firstly a need to look in further detail and secondly, key areas requiring further attention. This is what Argyris and Schön refer to as single loop learning (in Pahl-Wostl et al., 2010; see Table 9.1 (this document)). Yet the very process of developing and estimating the schedule has highlighted a different set of interrelated issues that underline the importance of looking across the infrastructure lifecycle, the wider system, and organisation. In many ways, these are equally, if not more important than the 'bottom line' as they are not only likely to influence the estimate but help to identify areas where attention is needed to affect systemic change. This is reflected in the discussion, to follow.

Consideration of these issues — detailed in Appendix VII and summarised in Table 6.2 — provides a further learning opportunity in which existing assumptions can be revisited within their existing organisational frameworks. Argyris and Schön refer to this as 'double loop learning' (in Pahl-Wostl et al., 2010; see Table 9.1 (this document)). It is noted that whilst this considers project-level matters, it does so from the perspective of the operator or operations division of the organisation. Consequently, this is not an audit of whether the project has delivered against its requirements (although it does touch on these matters). Rather, it considers the implications of what was found for operational practice and thence long-term, system-level outcomes.

Table 6.2: Summary of wider issues

Issues	Comments
General processes	
Information accessibility	No clear bundle of information aimed at operations: ▪ Information archived at end of project delivery including compliance material. Management systems may not assist as data may not be accessible or useable. ▪ Difficult to ascertain whether all requirements have been captured and to track changes arising during delivery.
Issue salience and summing of the parts	▪ Project versus operational: 'Best for project' sometimes prioritised over long term or operational matters (e.g. poor whole-of-life design choices). Compounded by project delivery objectives (delivery cost, programme, construction safety and compliance) which do not necessarily align with strategic objectives and system level project purpose. Costs may therefore arise in delivering missing components (CAPEX & cOPEX). ▪ Functional focus versus systemic need: Organisational belief systems can lead to assumed boundaries of accountability and belief that excluded matters are either dealt with elsewhere within

Issues	Comments
	the organisation or not the responsibility of the functional area. Costs that are not cOPEX but still a cost to the organisation (e.g. completing project actions after practical completion) therefore become 'hidden' by being absorbed. Sum of parts does not equal total cOPEX / cost to organisation. ▪ Familiar versus less defined: Preference for scheduling assets conventionally found in conventional databases. For example road marking was estimated to the nearest dollar and structures maintenance and renewals were absent. Issue with management tools becoming decision-making proxies. Requirements (and therefore costs) were shown to be greater than the sum of the parts; whole of organisation assessment required before dividing accountabilities across structure or function.
Compliance	Integration of compliance requirements: Largely omitted from cOPEX, raising larger issues of risk and liability, plus potentially significant costs in completing or rectifying mitigation requirements. This also has a potential impact on project benefits as compliance linked to social and environmental outcomes. Compliance also relates to the following matters, which have been integrated in the issues that follow: ▪ the purpose of project documentation; ▪ the completion of project delivery requirements; ▪ third party interfaces; and ▪ consequential operational implications.
Strategy and project planning	
Business case and funding	Business case or funding assessments of 'whole-of- life' is not necessarily suitable for calculating cOPEX from an operational perspective. Meaning also potentially lost in translation. Does not include maintenance or renewals beyond 40y horizon even though requirements for major structures (for example) may exponentially increase towards the end of their design life. cOPEX also not always be included in other project scheme assessments and attention to operations not part of industry Gateway processes until completion of construction (State Services Commission, 2010, 2013a, 2013b,

Issues	Comments
	2013c, 2013d, 2013e).
Project planning and approvals	Project documentation not focused on operations and often cursory consideration given in documents. Highlights the need not merely for inclusion of maintenance with design and consenting documents but rather a set of documents to be prepared specifically from the operators' perspective. This would not only facilitate handover but contribute to an improved cOPEX assessment early within the project delivery cycle.
Benefit management	Omission of requirements may artificially lower cOPEX and erode benefits and / or levels of service. This may not always be obvious as this may manifest at the 'system' rather than asset or project level. Also, the effects of any omission may not be realised within the system that manages it (e.g. externalised effects on society or the environment), and / or the effects are only realised in the long term (e.g. shortened asset life). Consequently cOPEX related omissions may not be 'seen' within the infrastructure organisation.
Project delivery	
Design and construction procurement	Operational requirements need to be bolstered within contract documentation and written specially to meet the requirements of the operations teams. This particularly needs to consider how the information is to be accessed and used. Designs need to give more than cursory consideration to maintenance (e.g. 'robust materials equates to low maintenance'), and to specifying exactly which parts of standards and guidelines have been applied. Consideration also needs to be given to organisational capability and capacity, which may also affect budgets ahead of project delivery.
Project completion	Additional organisational costs (may not be cOPEX) are omitted and otherwise not directly captured. This includes those costs associated with resolving secondary project consequences (e.g. archaeology), completing mitigation, completing other compliance requirements (e.g. monitoring). Omissions become absorbed or result in consequential spend that was not anticipated.

Issues	Comments
Deferred benefits	Aligned with benefit management but relates to the reconciliation of statements with project assessments with the finally delivered scope. Examples were often found in relation to claimed improvements to connectivity except that the delivered asset did not connect to a wider network. This raises issues in relation to benefit: cost assessments and the ability to later justify smaller projects to 'join the dots'. This suggests there is some merit in variable project envelopes by mode particularly where walking, cycling, public transport envelopes might logically differ from general traffic.
Operations	
Handover processes	Clear need to improve handover requirements and to ensure full integration of the project into the operational system. Not all requirements had been delivered (especially compliance requirements), or were available meaning not everything could be costed or understood by operations. Whilst changes to the handover area would be an obvious first step, limiting improvements to this area is unlikely to achieve an effective change as the issues are complex and interrelated.
Maintenance specifications and requirements	Largely focussed on hard assets, these need to include non-standard (e.g. architectural features, 'blue-green' stormwater management), or consequential impacts (e.g. ongoing contaminated land or archaeological requirements) arising from the project. Consideration as to how variations are managed for non-standard items is also required around precedent, efficiencies, and organisational capability.
Organisational interfaces	
Organisational integration	See also 'issue salience and summing of parts', above. Significant scope but uncertain cost associated with incremental changes to the 'cost of doing business'. Introduces impacts on transparency, and uncertain accountability. Particularly noted for tasks associated with compliance, social or environmental outcomes, mitigation, risk, adaptation and evolution. Whilst costs may be difficult to define this does not abrogate responsibility.

Issues	Comments
Third party interfaces	The study project had a number of operational interfaces with third parties for areas such as rail, dam and stormwater management, parks and landscaping, and traffic control. Because requirements had not been identified and included in a schedule, both costs and transfer requirements had not been fully determined. This included issues with future performance auditing, and follow through.
Programme staging	The implications of delaying future stages on the benefits delivered in Stage 1, the need to undertake deferred maintenance or upgrade 'temporary' project interfaces was unknown. This could add additional cOPEX and also CAPEX is auxiliary works are required to adjust interfaces.

6.3.3 Influencing change

Complex issues are unlikely to be resolved with linear thinking or a single solution, which can be challenging for a technically-based organisation (Bosch et al., 2013). Although cOPEX might be viewed as simply a project–operations handover matter and thence the reliability of the estimate, the range of wider issues (Section 6.3.2, Appendix VII) demonstrate the reality is much more complex. Figure 6.1 presents those same issues graphically, showing the linkages and connectivity between the various factors (established from the detailed assessment; see Section 6.3.2).

Figure 6.2 is a similar output from a short workshop aimed at refining the short-term focus for practitioners (see Appendix II, Section AII.3). What these figures show is that whilst the handover and estimating processes might be a good place to start, attention will need to be given to the wider system. This is particularly if change is to be both effectual and enduring (accountability, culture and budgets are once again central themes).

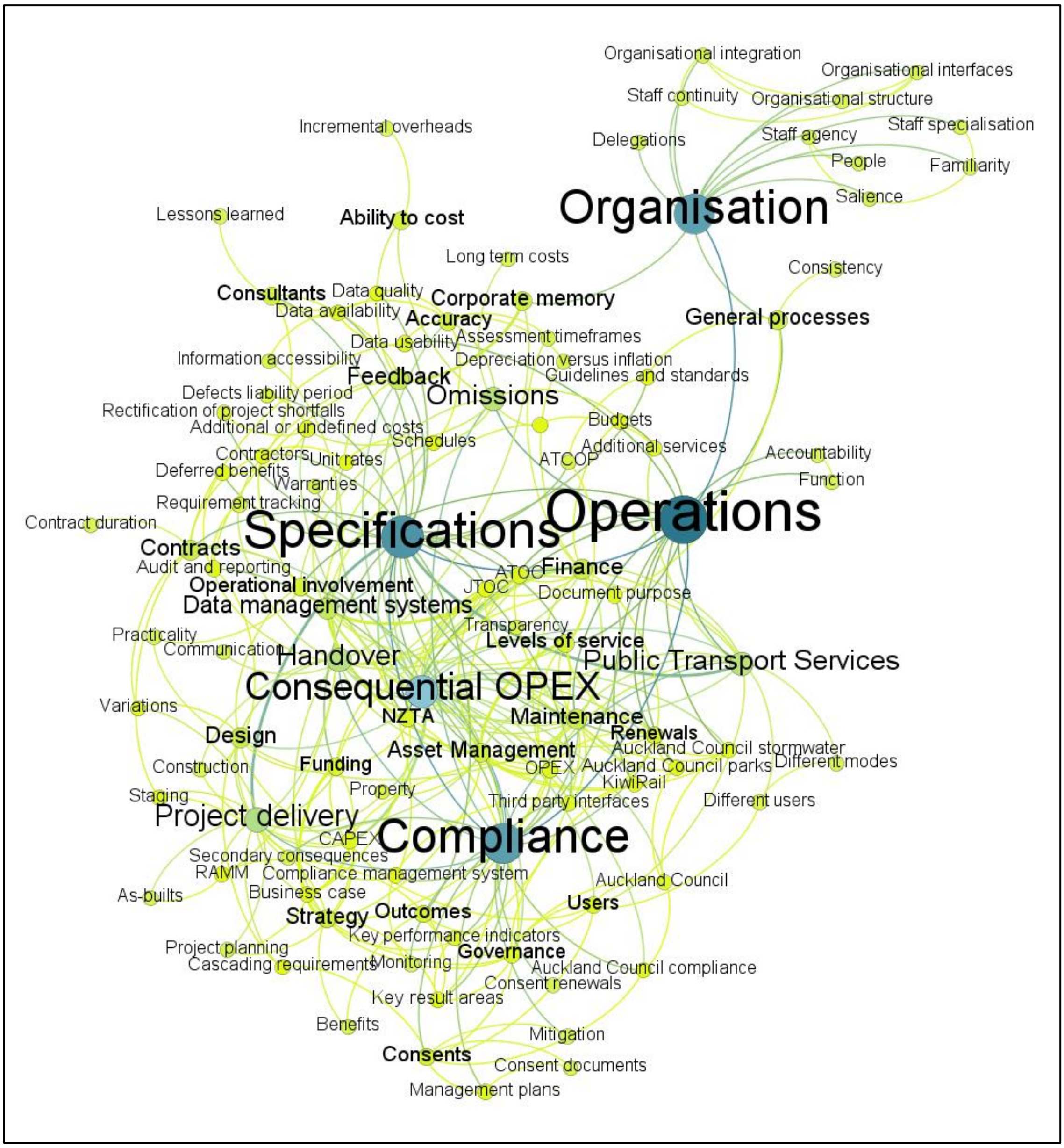


Figure 6.1: Mapping of consequential OPEX-related issues

Note: Node and edge (connection) colouring denotes issue/factor communities. Text/node size indicates level of influence. These show the connectivity of issues/actions, establishing a hierarchy to assist the organisation prioritise its response.

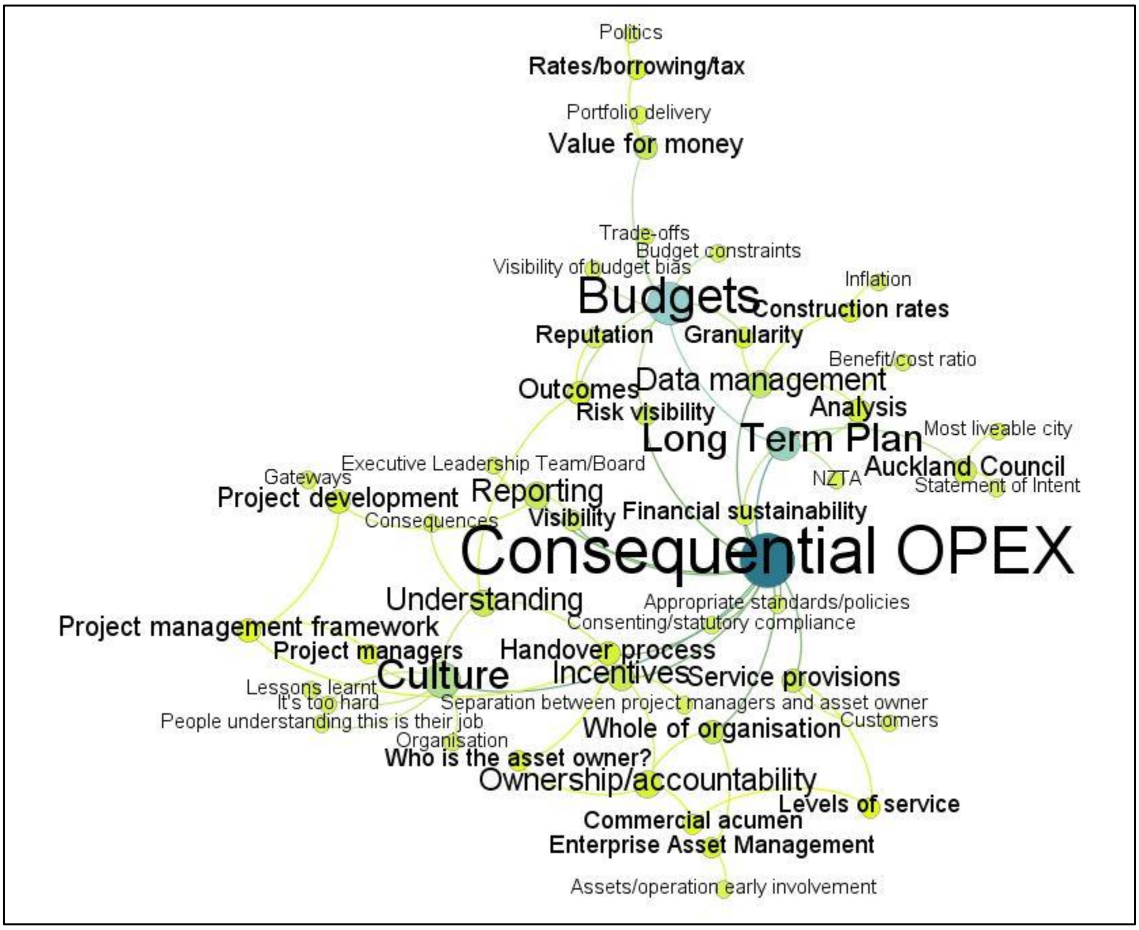


Figure 6.2: Practitioner mapping of required change

Note: Node and edge (connection) colouring denotes issue/factor communities. Text/node size indicates level of influence. These show the connectivity of issues/actions, establishing a hierarchy to assist the organisation prioritise its response.

6.4 Detailed study 2 discussion

Bosch et al. (2013) use an iceberg analogy to describe the management of complex issues. They argue that the obvious symptoms or quick fixes are only a very small part of the approach required and rarely offer long-term solutions. Instead, they suggest a further three levels of thinking which "*hardly ever comes to the surface*" (Ibid., p.117). Interestingly, these aligned with three of the key points that warrant further discussion around this matter of cOPEX:

- change management (including interactions between components);

- controlling (mental) models; and
- system structure.

One further matter relates to the implications of this study for infrastructure governance and high-level decision-making. Governance in this context relates to the board level rather than political function.

6.4.1 Change management

In addition to responding to the issues surfaced through this detailed study (i.e. 'corrective action'), there is of course a second dimension to the matter of change management in this context. It is one thing to change the existing system, it is quite another to respond to the dynamic nature of (or change to) that system (proposition 3). This is where the conventional linear representation of the infrastructure is singularly unhelpful (Figure 1.1). Whilst there may be a view that projects have a life of their own (Flyvbjerg, 2009; Flyvbjerg, Bruzelius, et al., 2003), ultimately projects should respond to an operational need, which is in turn providing a societal outcome. A systems lifecycle, such as the model proposed by Blom (2014), is perhaps more helpful in this regard (Figure 3.1). The current penchant for 'best for project' needs to urgently be refocused at the system level and ultimately the end user or community.

Whilst the wider issues of the existing system will be a good guide for managing the transition of projects back into the operational system, this will need to be periodically reviewed (discussed next). Goodman and Ramanujam (2012) have identified three areas of change which they suggest needed to be addressed if change is to be effectual at the organisational level: people, organisational structure, and technology (taken to also mean technical change in this context).[94] A change matrix results if these are combined with the central themes identified by this study (Figure 6.3).

[94] This accords with others such as Lozano, Nummert, and Ceulemans (2016) and includes both internal and external considerations after Freeman (2010); Freeman and McVea (2001).

Change dimensions (Goodman and Ramanujam, 2012) / *Key issues**	**People**	**Organisational Structure**	**Technology / Technical**
General processes			
Strategy and project planning			
Project delivery			
Operations			
Organisational interfaces			

** Note: Key issues sourced from Appendix VII. Sub-issues should be identified on an organisation and / or project specific basis, but those identified by this study may provide a useful starting point.*

Figure 6.3: Whole-of-life change matrix

The detail within Figure 6.3 under the 'key issues' has been purposefully omitted, but if populated on a context-specific basis, the matrix could provide a simple cross-check for practitioners that all of the key issues and dimensions have been addressed for whole-of-life (i.e. ongoing) change. For example, Auckland Transport could populate the matrix with the issues identified within Figure 6.2, and use this to develop an organisational change process.

Goodman and Ramanujam (2012, p. 20) caution that negative change "*can result in an unintended, and often unacknowledged, risk: a buildup of latent errors in operations.* [Managers] *must consider ways to enhance organizational attention and memory during and after the implementation of major change*". This may well be true, but given Goodman and Ramanujam use Dekker's definition of latent errors,[95] this does not go far enough. Rather, this study has indicated a need for

[95] "*Deviations from rules and standard operating procedures that can potentially result in adverse outcomes of organizational significance*" (Dekker in Goodman & Ramanujam, 2012).

there to be a continual review of processes and procedures. It is argued next that sometimes this needs to be more than incremental change.

The overarching point here is that the transfer of a project into the ‘system’ creates ‘threads’ of action and change that need to be followed through that system, and there needs to be accountability for doing so. The corollary is that all dimensions and all the key issues within the matrix need to be addressed to reduce the likelihood of similar problems being encountered in the future (propositions 2 and 3). Ongoing change, and change management will be important in an evolving system, modified by project delivery and changing context (Sutcliffe, 2011, p. 137):

> *Reliable performance in complex systems is complicated because it is a dynamic, non-event that is difficult to specify and visualize. It is dynamic because safety is preserved by timely human adjustments; it is a non-event because successful outcomes rarely call attention to themselves. Because reliable outcomes are constant, there is nothing to pay attention to. This can decrease vigilance, the sense of vulnerability, increase the propensity towards complacency and inertia and decrease the quality of attention across the organisation. This can be deadly. Although adverse outcomes, sometimes, occur because of performance and execution mistakes, there are flaws in that portrayal. Mistakes in perception, conception and understanding lead to much greater harm.*

6.4.2 Controlling models

Multiple departments and disciplines need to contribute to the assessment of cOPEX. Moreover, any approach needs to be more than the summing of parts to provide a whole-of-organisation, whole-of-life cost. Both Bosch et al. (2013); and Newell et al. (2005) observe the importance of mental or controlling models when integrating different functions, departments, or disciplines. There are two areas where this study suggests that convention, and therefore the associated controlling (mental) models, merit a review.

The first relates to the prevalence of the project-oriented mind set, organisational structures, and general industry practice prevalent not only within the subject organisation, but within the wider infrastructure industry. This has already been touched upon,[96] but is considered to be crucial for effecting change going forward.

The second relates to historic context. The current practice that surrounds project delivery and the estimation of cOPEX draws upon industry convention and organisational learning. In other words, ‘history’. In this instance Auckland Transport has had the opportunity to draw upon best practice from its ‘legacy’ council organisations. This can result in incremental change which is, in many respects, a form of institutional lock-in as it gives the impression of change but does not fundamentally reflect on the underlying mental models. This in turn may give rise to a sense of stability, something Snowden (2003, 2005) and Sutcliffe (2011) tell us is problematic. The longevity of infrastructure will only serve to exacerbate this sense of stability.

Several points emerged from this study, which suggest it is timely to review how not only the matter of cOPEX is approached, but the overall management of infrastructure:

- Relevant information and costs were readily available for simple road-related assets, but significantly curtailed for complex or non-standard assets.
- Much of Auckland Transport’s forward development programme and its overarching strategic objectives relate to transformation (Auckland Transport, 2013a, 2014d). Most of the significant projects (and therefore expenditure) relate to complex (technical, environmental or other contextual matters) and/or multimodal projects, many of which interface with other organisations.
- Whilst the widespread use of prorated estimates might have been considered by infrastructure organisations to be appropriate, this was based upon considerable lengths of reasonably uniform road corridor, so variance was more likely to be absorbed within the averaging effect of that network.
- By contrast, there is not the same quantum for emerging complex assets, and therefore the ability to both schedule and cost in a way that adequately reflects the complexity of the asset, is much more important than before.

[96] See also Blom (2014) and Blom and Irwin (2011), and more recently Lenfle and Loch (2015).

Whilst obviously an issue for the matter of cOPEX (i.e. cost and performance information for novel assets need to be gathered then used), this also raises the bigger question of whether current approaches to infrastructure management are still relevant and appropriate. New Zealand, like many ‘new world’ or post-World War countries, has undergone a sustained period of infrastructure growth. Although this continues, the nature of that growth has changed. Within Auckland’s transport context, the focus has shifted from simply infrastructure delivery (as a series of projects) to ‘transformational shifts’. The above-mentioned points, visible at the cOPEX level, may well have the potential to inhibit Auckland Transport’s ability to meet its long-term objectives and strategies. Changing the controlling models, or the way in which infrastructure is viewed within the organisation as a whole, will therefore be an important part of an organisation’s ability to change, adapt, and learn. It would be expected that Auckland would not be alone in facing this issue (Chapter 3).

6.4.3 System structure

Although the definition of OPEX is very simple and all encompassing, it was apparent from this research that at a practical level, it is not managed as such. Accountability for ‘a figure’ rests with one part of the organisation, but this does not include other contributing costs such as from public transport services. However, even if collated, this is still the sum of parts, and appears to be driven from functional reporting and data management tools rather than the actual overall costs. The study identified many underlying reasons for this but significantly, arising costs did not always neatly fit within currently defined budgetary categories and so were omitted. If this is not understood, like the definition of ‘whole-of-life’ costing, this will be lost in translation, and there will be an expectation that OPEX figures are a holistic and all-encompassing assessment of ongoing operational costs.

Currently, and in simple terms, CAPEX consists of new project expenditure and asset renewals, and OPEX covers maintenance, services, and asset management. Maintenance and renewals are a sliding scale, so the threshold above which works are classified as OPEX or CAPEX may vary over time or from organisation to organisation. These components are identifiable within Figure 6.4.

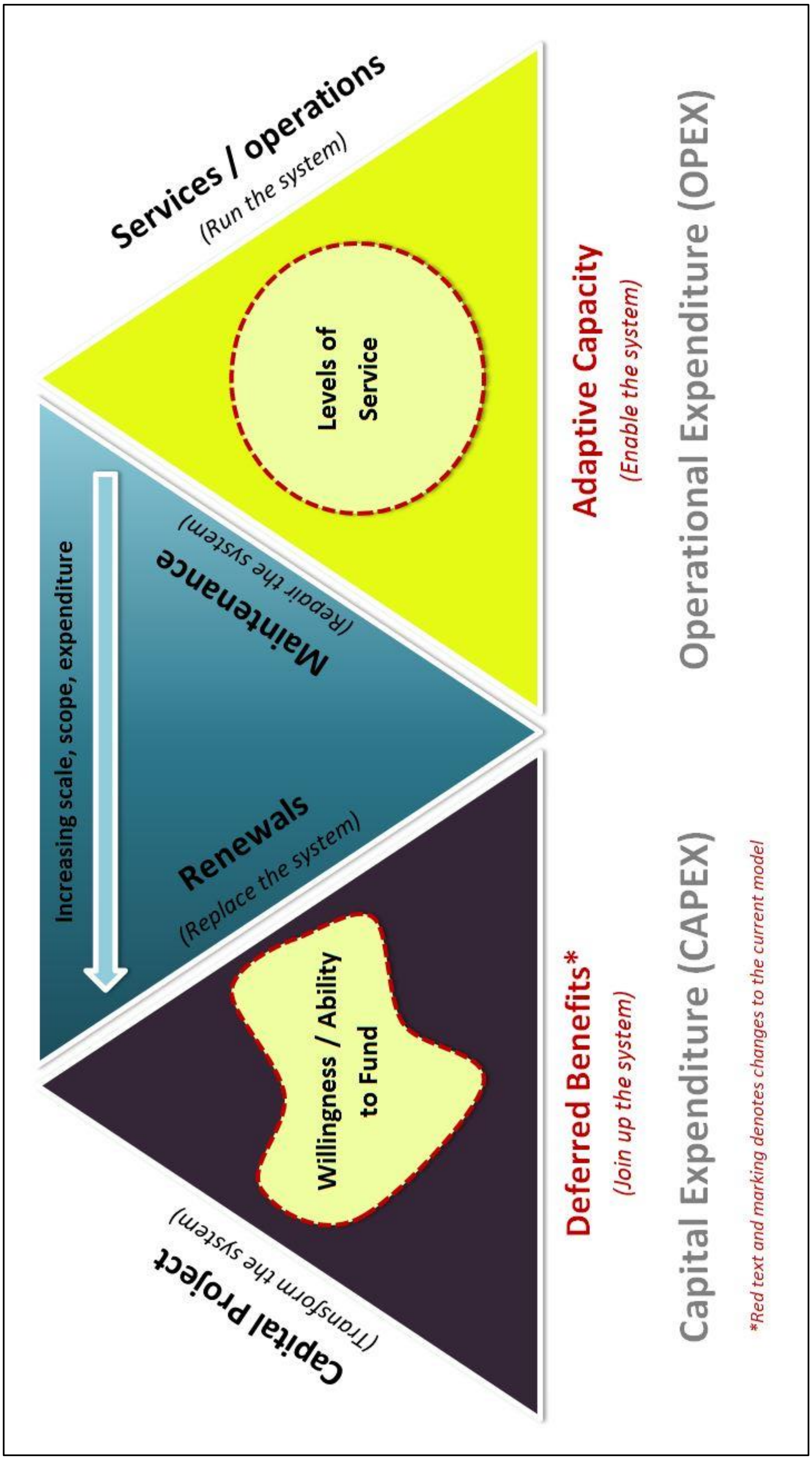


Figure 6.4: Visualisation of the modified operating model

The interplay between maintenance and renewals is in itself significant as (Controller and Auditor-General, 2014b, p. 14):

> *Local authorities adopted financial strategies that included "just-in-time" responses to growth-related capital expenditure. Many reduced the forecast level of renewals and took a "sweating the assets" approach* [...] *and adopting "run to failure" approaches — which meant waiting until a component stopped working before replacing it, rather than replacing a component before it failed.*

This interplay has implications for how long-term maintenance and the associated budgets might be perceived (see also levels of service, below, and Section 6.4.4).

Aside from the completeness of the OPEX estimate itself, there were two particular areas where costs were being omitted from the wider organisational system, both of which require a different means of managing funds than the current approach:

- CAPEX-related deferred benefits: These are the 'claimed' project benefits that are not delivered due to scoping, specification, lack of follow-through, budgetary constraints, or other reasons. Many relate to connectivity to a wider network such as bus priority measures, walking or cycling.
- OPEX-related adaptive capacity: This includes components that have the potential to arise over time such as emergency scenarios including natural disaster. However, these are also as much about enabling the organisation to adapt and respond to change as they are to responding to risk. These include provision for technology or compliance requirements through review or renewal, future proofing, resilience-related initiatives, and opportunistic works.

Providing for these two matters would produce a new operational model, a visual representation of which is shown in Figure 6.4. This would not only provide a place for the more significant 'orphan' or currently hidden costs, but provides a tension between short- and long-term requirements. The approach should also increase transparency and certainty within the system.

An associated matter is level of service, which relates to delivering the whole-of-life outcomes of the asset such as design life or services provided. Operational service levels can be affected by budgetary changes, or as seen through this study, get degraded through (for example) project decision-making, 'handover disconnects',[97] or lack of specification. Instead, it is suggested that operational levels of service should be fixed relative to how they were proposed (or at least provide a baseline for improvement over time). Any reduction should be related to need rather than budget boundaries acting as a proxy for such. This is also linked to the 'adaptive capacity budgets' for improvements to, or reorientation of, levels of service). Any discretion should rest within the CAPEX phase, and in particular how investment is focused.[98] This is aimed at supporting the current strategy of doing more with existing assets, and underlining the role of CAPEX in transforming the system.

The final point within this Section is a challenge for those within finance (as this sits outside of the ambit of this research). The following issues were raised during this research, and it is clear that the current accounting approach is not well suited to long-term OPEX in the infrastructure sector, and needs to address a range of matters, including:

- Budgetary horizons: Long design-life infrastructure such as structures will likely have little routine maintenance within short- to medium-term budgets. However, these costs do remain and will eventually enter the 'system'. Currently these costs are being 'lost in time'.
- Discounting versus inflation adjustment: Linked to the preceding point, because initial whole-of-life costings are completed for funding purposes, discount rates are used (and exclude long-term maintenance requirements). By contrast, inflation is applied to any ongoing OPEX figure (but it appears long-term costs are omitted as these were not material when assessed initially). Early project

---

[97] Meaning the disruption that can occur when infrastructure transitions between lifecycle stages and is 'handed over' from one function/division to another.

[98] This is shown in Figure 6.4 within the left-hand, CAPEX triangle as a variable budget based on the willingness/ability to pay. The identified need to secure operational levels of service is shown as a fixed/defined shape within the right-hand, OPEX triangle.

and ongoing assessments of OPEX need to be undertaken from the organisation's operational perspective not just for funding purposes as they are asking and answering different questions.

- Non-conforming assets: Some assets, for example travel demand measures such as the 'walking school bus' (resource cost rather than a tangible asset), or appreciating assets such as riparian margins and wetlands may not sit neatly within standard accounting frameworks. Accounting imperative may therefore result in perverse outcomes or drivers.
- The use of time-dependent (use it or lose it) budgets can be unhelpful in the operational preparation for project delivery (e.g. if the project is delayed), or in providing for the adaptive capacity of the system. Whilst there is a tension with rating practice and issues with the establishment of large contingency sums, this does not seem to be well provided for at present.

This is not to say that the system should be made unduly complicated, but rather high-level changes are required to improve the system structure, and to provide better transparency and improved accountability for delivering strategic outcomes.

6.4.4 Governance

This study will also have implications for governance (proposition 2), in at least the following areas:

- OPEX-specific: The true cost of OPEX, once known for the originally proposed levels of service, will have an influence on high-level strategies and decision-making, and in particular the relative emphasis placed on maintenance and long-term outcomes.
- More generally:
  - Well established management tools may promulgate a sense of certainty but may include significant levels of uncertainty and omission. The complexity of the contributing processes and organisational matters may make this difficult to 'unpick' when presented at a high level and may be masked by terminology, perspective, and expectation.
  - The dynamic and complex nature of infrastructure as a system requires change management and a periodic review of controlling mental models, both of which would benefit from governance leadership.

6.5 Detailed study 2 conclusions

A summary of the key points from the deep dive are provided within Table 6.3.

Table 6.3: Summary of the whole-of-life management deep dive

Project—operations transition: Whole-of-life management (Auckland Transport)	
How is the misalignment being generated (what are the reasons for the misalignment)?	
cOPEX estimating practice	▪ Actual cOPEX unknown — inhibits feed forward, learning, feedback. ▪ No whole-of-organisation approach. ▪ Whole-of-life may have different scope/meaning. ▪ Dominated by familiar assets — services and multi-functional assets not well provided for (more often missing). ▪ Investment processes over-reach (e.g. long-term cOPEX missing including for major structures). Investment not operationally focused. ▪ Best for project can hide some costs. ▪ No provision for change, events, adaptive management.
Assessment of wider implications	▪ Dominated by project processes — best for project. ▪ Embedded misalignment through institutional lock-in. ▪ Information not accessible post-project nor prepared for operational needs. ▪ Assumed accountability boundaries/belief that excluded matters are dealt with elsewhere. ▪ Other costs/actions (e.g. project defects, compliance) not in budgets (absorbed/hidden). ▪ Known requirements not transferred — become unknown unknowns. ▪ Deferred benefits — over-claimed system benefits in business cases. ▪ No feedback/feed forward. ▪ Third party disconnects. ▪ No programme staging reviews.

Project—operations transition: Whole-of-life management (Auckland Transport)
Effects
▪ Can have material impact upon total system OPEX — need to understand these are not from new but omitted requirements. ▪ Overplays project benefits and underplays operational requirements. ▪ Hidden system benefit loss through inadequate OPEX spend. ▪ Omitted cOPEX equates to omitted actions/levels of service/outcomes — narrow asset-centric focus. ▪ Does not support strategic intent. ▪ Poor cOPEX estimating impacts on future budgets/opportunities /levels of service/outcomes. ▪ Erodes services, multi-functional assets, mitigation, trans-organisational/departmental (wider) outcomes and long-term asset life/performance.
Implications and interventions
▪ Change needed to cOPEX estimating practice, particularly for system transforming projects. ▪ Need to follow project threads through organisation/system so fully integrated/embedded. ▪ Whole-of-organisation approach to whole-of-life required. ▪ Deferred benefits and adaptive capacity need to be understood and managed. ▪ Corporate process (e.g. accounting/finance) also needs to align to outcomes. ▪ Governance to reflect on true OPEX and drive ongoing system review.

This study has provided useful insights at two levels. Firstly, it has provided an in-depth study of how cOPEX is estimated and managed. This has highlighted a complex series of compounding issues that raise questions about veracity of cOPEX estimation and indicate that many factors are being lost in either translation or time. Eroded levels of services may not be immediately apparent as they may not manifest within the system in which it is managed (e.g. effects are externalised to the environment or society), or may not manifest within conventional business timeframes (e.g. effects or implications are not realised within 40 years). This in turn raises a second order of issues which relates to the impact that a series of wider issues have upon long-term infrastructure outcomes. The study corroborates earlier research which indicated that more attention needs to be given to the system perspective of infrastructure and the organisations that manage it (Chapter 3). After all, as stated in Chapter 1, this is arguably the level relevant to, and the reality of, much of the realm of day-to-day public infrastructure management.

Whilst the research has highlighted significant underestimation of cOPEX, the effect on the bottom line is only part of the equation. It is, perhaps, less relevant than what the study has shown about the wider issues within the technical-organisational realm and the context in which this sits. In the least, the study qualifies the performance management maxim: you can’t manage what you don’t measure, ‘and don’t have a budget for’. It is necessary to add: but first you need to know what you are both required and intending to achieve.

There is considerable scope for additional research on this matter. Whilst this could include additional case studies, and/or other infrastructure sectors, there remain auxiliary questions such as what happens when assets are ‘vested’ to the public by a private developer, and whether alternative procurement, such as public/private partnerships necessarily address or defer the issues raised here. This study also levels a challenge to those in finance to develop accounting practice that better facilitates and responds to the specific needs of public infrastructure administration. Finally, the research underlines the need to research the interface between engineering and management as it relates to infrastructure practice, but to do so with a focus upon long-term system outcomes.

Public infrastructure assets are a reflection of the development legacy, and of both past maintenance practice and budgetary factors. Cromwell (1991), for example, suggests that the dilapidated condition of infrastructure is not merely a reflection of the age of the existing capital stock, but rather an artefact of the compounding of project-oriented policy with bureaucratic and political pressures. With £40T of global infrastructure investment needed between 2013-2030 (USD$57T; Dobbs et al., 2013), understanding the long-term commitment to operational expenditure, and the actions and outcomes that underpin it, is paramount.

7 DETAILED STUDY 3

PERFORMANCE MANAGEMENT

The previous two detailed studies have both identified issues that disrupt the ability to align infrastructure management practice with its strategic intent. This last detailed study investigates the operations to strategy interface of the infrastructure lifecycle, being the feedback process of the infrastructure lifecycle and final interface or transition to be considered here (Tables 2.1 and 4.1). Like the two earlier studies, it is aimed at providing clues or analogies to develop an understanding of the issues. The material, in turn, provides the evidence-base and inputs for the subsequent cross-case analysis that is to follow within Part III.

Brief description: Road smoothness as an indicator of the strategic objective (strategic intent) to improve customer comfort.

Strategic intent: The New Zealand Transport Agency (NZTA) is charged with delivering "*an effective, efficient, and safe land transport system in the public interest*" ("Land Transport Management Act," 2003). The organisation's outcomes and objectives (strategic intent) cascade into performance targets (NZTA, 2013b, 2014a) which includes the key result area 'improving customer comfort', as measured by road smoothness.

Contributing factors investigated (see Table 3.1):

- Performance (benefit) monitoring.
- Follow-through/reconciliation with system-level objectives. Feedback to strategy development.

Organisation: NZTA (central government organisation).

Performance was one of the key matters to emerge from the preliminary research (Chapter 3). This study looks at a common sector performance measure — road smoothness — which has been adopted by the NZTA as an indicator for one of its strategic objectives (customer comfort). By way of wider context, in the past two years, the Accident Compensation Corporation of New Zealand has recorded more than 53,000 "*falls annually in the road or street that have not involved motor vehicles*".[99] For the same period, the value of claims has an estimated cost of greater than NZ$52M per annum (Accident Compensation Corporation, 2015).

Conventionally, studies of this type have focused on the technical measures themselves. By contrast, this study has explored the engineering processes through the lens of the outcomes they sought to achieve, in this instance, customer comfort. This usefully provides a mechanism to engage with those that infrastructure both impacts and benefits, and as such, this aspect has relevance to both the other studies and the overarching research 'question'.

7.1 Introduction to performance indicators

During the 1980s, the concept of 'New Public Management' emerged, and with it, a greater emphasis on business-like performance and stakeholder collaboration (see Chapter 1). This has latterly converged in the realm of public infrastructure with the development of performance- or service-led infrastructure management, and is especially evident in asset management wherein level of service, or performance, is a key tenet (e.g. NAMS, 2007). Consequently, public infrastructure organisations, such as local government, are often required to articulate service-level objectives and to report regularly on performance (e.g. Department of Internal Affairs, 2013).

Infrastructure performance can be measured by defined levels of service across a range of factors including reliability, availability, capacity, and cost efficiency.

[99] This should not be assumed to be a fall that singularly results from tripping. The statistic encompasses a range of injuries and risks. Data on the root cause of the fall was requested but this is not currently recorded.

Whilst they may also be measures of performance, customer demand and need are also underlying objectives that are ultimately reflected in infrastructure strategy and service delivery (Controller and Auditor-General, 2014b; NAMS, 2007, 2008-2015). The importance of integrating customer need into infrastructure management is being reinvigorated as infrastructure providers reorient from a technical or project structured organisation to service-led delivery. This is further underlined as infrastructure managers seek to do more with existing assets.

Interface with strategic intent

Amongst its other functions (Appendix I), the NZTA manages New Zealand's State highway network, including maintenance, improvements and operations activities. It has recently articulated a series of long-term (20 year) goals, which see a renewed focus on customer service and outcomes (NZTA, 2014a). The aspirations (strategic intent) cascade into performance expectations, organisational key result areas, and performance indicators. In particular, these recognise that there is a need to better understand its customers' attitudes, needs and behaviours.

The study has a direct relationship with NZTA's comfort service key result area (improving customer comfort), which is measured by road smoothness. One of the secondary aims was therefore to assist the NZTA in integrating customer feedback within decision-making and prioritisation processes so that the services provided could be better aligned to customer needs. Accordingly, this also underpinned another strategic objective: making better use of existing assets (Ministry of Transport, 2013a; New Zealand Government, 2011b); see also Dobbs et al. (2013)).

7.1.1 Roughness indicators

The NZTA has adopted road smoothness as an indicator of customer comfort, technical conditions (e.g. surface and/or subsurface condition; D. Brown, Liu, and Henning (2010)), and road user costs. ASTM E867 defines road smoothness as "*the deviations of the surface from a true planar surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic loads and drainage*" (in D. Brown et al., 2010, p. 12). Many roads are of course not planar, but it is the deviations in the road surface that are of interest to this study.

The International Roughness Index (IRI) and the Smooth Travel Exposure (STE) are both measures of road smoothness that have been widely used internationally for some time (e.g. Geiger et al., 2005; Haas, Felio, Lounis, & Cowe Falls, 2009; Henning, Costello, & Tapper, 2013). Both measures purport to measure road user travel comfort and focus on how effectively changes in the longitudinal road profile are absorbed by vehicle suspension and then perceived by the user (D. Brown et al., 2010; Henning et al., 2013).

The NZTA currently measures the longitudinal profile of the highway network using lasers located over each wheel path, in conjunction with accelerometers fitted on the transverse beam of the survey vehicle. The IRI is then calculated from this longitudinal profile and reported every 20m (NZTA, 2009).

Despite its prevalence, the use of the IRI has been questioned (e.g. D. Brown et al., 2010). One of the concerns with the indicator is the adequate assessment of roughness from a human health and comfort perspective (e.g. Kropáč & Múčka, 2005; Lenngren & Granlund, 2002). By contrast, Haas et al. (2009, p. 6) argue that:

> *The public mainly notices the discomfort. Policy-makers can easily misunderstand a presentation of IRI as mainly a measure of ride comfort, and under-value the economic implications unless the transportation values of travel time and user cost are also presented. Thus, even though the IRI is objectivity measured, its misuse can cause its objectivity to be lost.*

The above-mentioned literature and several focused industry interviews[100] suggest that, from the perspective of customer-led infrastructure strategies, there are issues with the current indicators and approach:

[100] Six asset engineers from several New Zealand local authorities and different NZTA offices were asked for their views on (amongst other matters) the current measure and approach, and whether customer feedback affected decision-making (Appendix II, Section AII.4, DS3.1-DS3.6).

- the IRI and STE are vehicular measures and so do not necessarily provide a suitable index for other modes (e.g. cyclists, pedestrians), or customer (user) variability (e.g. children, elderly, mobility impaired);
- there is an inherent assumption that road smoothness is indeed a good indicator of comfort from the customers' perspective; and
- there is an apparent disconnect with how road smoothness is related to comfort, and then actually used by practitioners or decision-makers to change customer outcomes.

However, the issues do not mean that the indicators are not appropriate for the other technical uses to which they are put (Henning et al., 2013; NZTA, 2000, 2013c). For example, road smoothness, as an indicator of road condition, is now a mandatory reporting requirement for local government (Department of Internal Affairs, 2013). Consequently, this study does not consider the wider technical merit of the indicators for issues such as road user costs, road condition, or noise. Rather, the identified issues underline the need for this research, which considers the relevance of the indices from the *customers' perspective*, since this is how the performance strategies have been expressed.

7.1.2 Customer satisfaction indicators

Further review of industry and academic literature indicated that the use of roughness factors is often augmented by general customer satisfaction surveys. Such surveys frequently include road smoothness as one of the factors that customers are asked to prioritise or rank (notably, the customer is not involved in generating the range of issues being surveyed). For example, the NZTA contributes to the biennial user satisfaction survey undertaken by AustRoads (2011). However, such surveys do not enable direct comparison between IRI and customer feedback (see also Neely & Bourne, 2000). Furthermore, user satisfaction is multi-dimensional, does not solely depend on physical attributes, and does not necessarily accord with technical/engineering conditions (Department of Transport of Wisconsin, Iowa and Minnesota in Ramdas, Thomas, Lehman, & Young, 2007).

This was a recurring theme and was similarly the case with annual local government surveys (e.g. Key Research, 2013; Versus Research, 2013), as well as studies undertaken by, for example, Bonsall, Beale, Paulley, and Pedler (2005); Department for Transport (UK) (2012); Government of Karnataka (2004); Ramdas et al. (2007). This was acknowledged by Bonsall et al. (2005) who observe that few studies considered customers' beliefs. Indeed, there appear to be few related studies that consider the customer from the customers' perspective at all.

7.2 Detailed study 3 methods

Scope

One distinctive element of the overarching study method relates to its scope and New Zealand's jurisdictional boundaries. The State highway network ranges from roads with motorway status through to connecting rural highways. It also includes highways that pass through urban areas; paths are typically managed by local government along with the local road network.

However, funding and jurisdictional boundaries are not discernible (nor relevant) to customers (see Appendix VIII). The inclusion of urban highways and both paths and roads within the scope of this study is therefore unusual within this context. The broadened scope (which included all roads and paths, including 'share-with-care' and cycling paths, but not off-road tracks), was aimed at being more inclusive to enable interface issues (if any) to be explored. Typical road cross-sections are given within Figure 7.1.

Methods

This detailed study comprised three stages:

- customer workshops (and survey piloting);
- a national survey; and
- an investigation of influence and change.

The research design was initially based on a similar UK study (Ramdas et al., 2007), which focused on road smoothness as the indicator of comfort and condition. However, that approach assumed the customer was aware of road smoothness, and that it was important to them. Focus groups were therefore added to test the relative importance of smoothness in how condition and road performance is understood by customers, and to pilot the questionnaire. This methodological departure from the earlier study enabled this research to better orient to the overarching thesis.

Because the methods are so closely coupled with the analysis, the detailed methods are attached in Appendix VIII along with the detailed results.

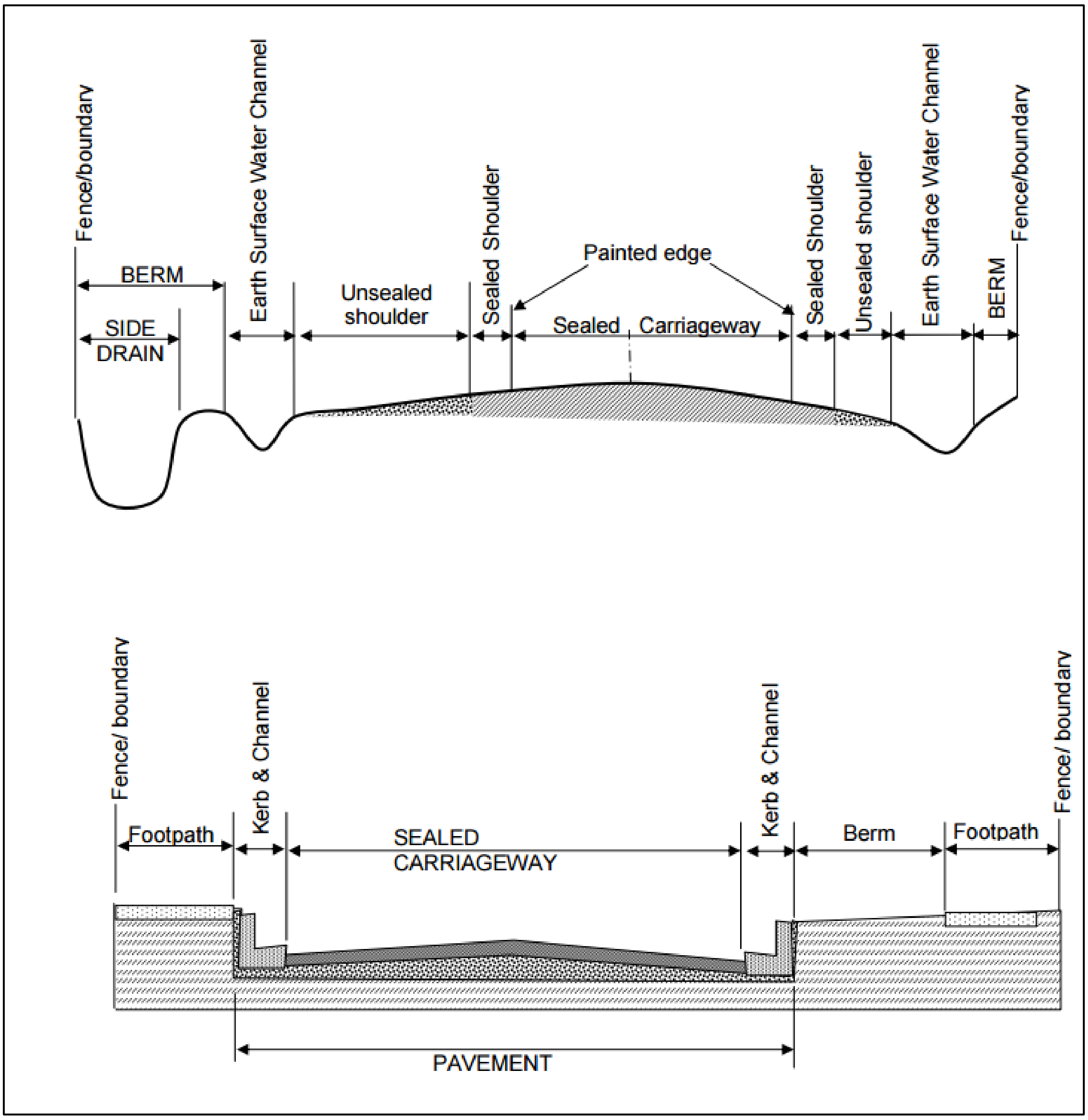


Figure 7.1: Typical road cross-sections

***Top**: Rural; **Bottom**: Urban*

Source: Transfund New Zealand (1997)

Note: In New Zealand a 'sealed road' is a generic term and so does not necessarily reflect the materials used to construct the road surface.

7.3 Detailed study 3 results

The results of this detailed study are attached within Appendix VIII. A copy of the questionnaire is also attached within Appendix IX.

7.3.1 Customer workshops

The customer workshops provided a rich source of information and insight into customer needs, and how this interfaces with organisational drivers and technical performance. It underscored the point that the notion of comfort is indeed complex.

With the establishment of smoothness measures and performance conventions, customers appear to be asked less frequently about their needs (see Sections 7.1.1 and 7.1.2). In the very least, it would be expected that customers would be asked periodically as both society and technology changes over time (e.g. improved vehicle suspension may affect smoothness requirements). Furthermore, the conventional approach of asking customers directly about road smoothness is likely to restrict discussions to tensions or competing requirements between user groups (e.g. cyclists might prefer smoother roads, but this might be dangerous for other user groups such as motorcyclists).

There is also an inherent assumption that smoothness affects comfort; indeed by failing to ask this question the approach runs the risk of comfort becoming an indicator for road smoothness. By contrast, customer feedback would suggest that road smoothness might cause discomfort, but not in itself result in customer comfort. As Steve Jobs once stated "*you've got to start with the customer experience and work back toward the technology — not the other way around*" (in Solomon, 2014).

7.3.2 Survey

The survey undertaken as part of this research appears to be the largest survey undertaken in recent times by the NZTA (see Appendix VIII, Section AVIII.2.2.4). Some 1,619 responses were generated from around New Zealand as a whole, giving a 95% confidence limit with an associated 1.96% margin of error. Consequently the survey has added to the insights into customer needs, and how this interfaces with organisational drivers and technical performance.

The survey reinforced messages from the earlier customer workshops that roads are generally good from the perspective of car users, but that more significant issues arise from the perspective of other modes and user groups, and in particular those that are more vulnerable. The survey also reinforced the importance of considering paths, interfaces between users, and also the interfaces between roads and paths. For example feedback indicated that there are many parts of the network without paths (or with paths provided on only one side of the road). In such instances, and on occasions when obstructions or other users blocked passage, the road became the sole means of access.

Indeed, the survey underlined the value and importance of liaising directly with customers. Surveys may not always be as detailed as in this instance, and the open-ended comments provided a level of richness that might otherwise be lost. The direct customer discussions at the workshops as well as the open-ended questions enabled customers to explain how they were interpreting terminology (which may be different to what engineers and others that manage the system may assume), which modal 'hat' they were wearing to answer, or to give further detail to explain why a given issue was important to them. Issues were often intertwined and inseparable from other performance areas (most notably, safety), and could be easily misconstrued if considered from a single perspective. This was often the case for comments relating to road surfacing matters, for example:

- Current maintenance strategies (patching versus reseals, frequent rework, programming, and other practices), was one of the key factors affecting overall levels of satisfaction with roads. This was able to be distinguished from other road surface related issues from the detail of the comments. This might otherwise have been rolled into a single indicator relating to road surface conditions.
- Whilst the quality and smoothness of pavements was important, so too were other factors such as the presence of loose material, the practice of sweeping loose material to the side of roads (in the path of cyclists), tar bleeds and slippery smooth surfaces, the use of metal covers, bumps around manholes, and the extent of seal on shoulders, and issues forcing customers to swerve (amongst other factors).

- The quality of shoulders (and the extent of seal, surface transitions, and other factors) was important to cyclists (shoulders often cited as a de facto cycle lane), or to pedestrians and other users forced to walk on the road for a number of reasons, such as:
  - paths are sometimes not present along the network;
  - paths abruptly ending or switching sides of the road;
  - path condition (too bumpy, undulating, broken);
  - obstructions on paths;
  - crossing points are not available or suitable (e.g. wheel chair users getting out of cars having to travel down the road to gain access via a driveway or kerb crossing);
  - paths are too narrow, steep, or highly cambered making the road a more attractive (or only) option.

7.3.3 Influencing change

Whilst inevitably dynamic with time and perspective, the ‘influencing change’ exercise does show how simply changing a performance indicator or metric is not enough on its own; even at the most basic of levels, ‘targets’ and ‘measures’ are only two of the myriad of areas where the need for change was identified (Appendix VIII, Figure AVIII.19). So a change in indicator or the metric comprises only a very small part of the overall picture.[101] Of interest and relevance to the wider research programme, was the inclusion of ‘consequential operating expenditure’ and ‘measuring benefits’ within the identified actions/issues; both of which are the subject of the previous two detailed studies in this thesis.

7.4 Detailed study 3 discussion

As New Public Management, infrastructure and asset management principles have all co-evolved, synergies have emerged, particularly in the area of performance

[101] See Section 3.5, and the view expressed by Bosch et al. (2013, p. 116) that “*despite many efforts to deal with these complex issues facing our society, the solutions so far have seldom been long lasting, because ‘treating the symptoms' and ‘quick fixes', using traditional linear thinking, are the easiest way out, but do not deliver the solutions*”.

measurement and the establishment of service delivery indicators. However, indicators are exactly that. At the strategic level they can provide a health-check on performance (Franco-Santos et al., 2007). They should not dictate or comprise the organisation's actions; but action is required if the indicators are to be used effectively (Kennerley & Neely, 2003). Each indicator may also have very different underlying objectives, and sometimes seek multiple, perhaps conflicting outcomes. The road smoothness indicator for comfort is one such example. It is a relatively simple measure that acts as an indicator for several outcomes, and in relation to a range of organisational accountabilities.

Road smoothness and comfort

The NZTA has adopted road smoothness as an indicator of customer comfort, technical conditions, and road user costs. The use of measures such as the IRI, and its association with comfort, appears to be in line with general international practice. However, there are few studies in this sector that take a step back and ask customers what comfort means to them more broadly, and whether smoothness is the best or sole indicator in this regard.[102] Moreover, there does not appear to be any published or otherwise available work that directly compares changes in the smoothness indicator with changes in customer satisfaction (i.e. customer needs and outcomes).

Kennerley and Neely (2002) assert that performance measures should be dynamic and reviewed over time. In this vein it would be expected that customers would be asked periodically about comfort requirements as both society and technology changes over time (e.g. improved vehicle suspension may affect smoothness requirements (D. Brown et al., 2010); the emergence of motorised mobility scooters). This same point applies more generally within the ongoing management of customer-oriented outcomes in a continually evolving system (proposition 3).

However it is cautioned against taking a conventional approach to such inquiry. Asking customers directly about road smoothness is likely to restrict discussions to

[102] The issue of perspective in public services was canvassed in the 1990s with regard to cultural safety in New Zealand healthcare; see Koptie (2009); Ramsden and Spoonley (1993).

tensions or competing requirements between user groups (e.g. cyclists might prefer smoother roads, but this might be dangerous for other user groups such as motorcyclists). This constraint was highlighted by this study, in which the workshops inverted the conventional approach of starting with a given range of factors and in so doing gained a broad insight into customer needs. The customers themselves noted this during the workshops and valued the ability to gain an understanding of other's needs. This approach also enabled these 'non-discursive' elements to be explored (Hillier, 2007). These are aspects "*we experience largely subconsciously and which we often do not have language to describe*" (Penn in Knight & Ruddock, 2008, p. 16).

The results from both customer workshops and the more detailed on-line survey show that whilst road smoothness is both a frequently identified and critical comfort factor, the notion of comfort is complex. The workshop had previously identified comfort as comprising both emotional and physical attributes. This was reinforced through the survey with customers using emotive terms such as 'scary', 'wish', 'frustration', as well as commenting on a range of physical issues.

One aspect to emerge more rigorously from the detail of the survey is that customer comfort on roads and paths appears to have two further dimensions to it, each with a physical and emotive component:

- 'How I live my life comfortably' ('I can get where I want to, when I want to, and don't feel excluded').
- 'How comfortable I am on the asset' ('I have a pleasant experience, and I don't feel unsafe or vulnerable').

Indeed, the survey reinforced much of the feedback from the earlier focus group workshops and underlines the value and importance of liaising with customers directly and face to face. Both the workshop discussions and the open ended survey questions enabled customers to explain:

- how they were interpreting terminology (which may be different to what engineers and others that manage the system may assume); and
- which modal or user group 'hat' they were wearing to answer.

It also gave customers the opportunity to give further detail or to explain why a given issue was important to them.

Comfort cannot, therefore, be considered in relation only to a single asset or mode if it is to have any real meaning to those the outcome is intended to benefit. Although the NZTA has a range of other performance indicators that might arguably address some of the wider comfort requirements, this study has highlighted that there are limitations with taking these at face value or without considering the interplay between measures. In the least, feedback would suggest that any measure of smoothness needs to target:

- the ride-lines of the various users, and modes;
- footpaths;
- transitions between road and footpath; and
- the road cross-section (inclusive of the road shoulder and transitions).

The study demonstrated that customer comfort is one result area that might lend itself to being refocused on vulnerable modes and users and broadened to accommodate the less tangible notions of comfort. The research also highlighted the importance of broadening perspectives on mode use and need, for example:

- Currently, bus accessibility might be considered only in terms of timetabling and route, not the ability to access the bus stop and bus (usability).
- There are also many parts of the network without paths (or with paths provided on only one side of the road). In such instances, and on occasions when obstructions or other users blocked passage, the road became the sole means of access. In any event, as one customer observed, a pedestrian’s journey does not stop at the edge of the road (and conversely car drivers need to move from their cars to the side of the road).
- Increasing footpath width (to allow for socialising, reduce conflict, and provide for new modes), and improved cycle lanes (width and connectivity), would also contribute greatly to improved customer outcomes.

A much more holistic view of asset use, design, and management is therefore required.

Relationship with strategic intent

It is noted that under s.94 of the LTMA (2003), the defined objective of the NZTA is to "*undertake its functions in a way that contributes to an effective, efficient, and safe land transport system in the public interest*". The inclusion of 'public interest' moves the transport system beyond artefacts and assets, to social outcomes, and this is reflected in the NZTA's strategic objectives. Presently the comfort key result area is only partially served by the road smoothness measure by targeting roads and some users only. An asset-based approach is arguably a narrow view of what constitutes infrastructure, and may now be at odds with the organisation's recent strategic focus on customer outcomes.

All this is not to suggest that the IRI or road smoothness should be abandoned or is not an appropriate measure. Rather, there is an opportunity to consider whether there is a measure that is either 'mode agnostic' and/or better targets the vulnerable user, and in so doing provides more integrated and inclusive system-level outcomes.

The NZTA is unlikely to be alone in facing this issue, indeed as Moodley (2015, p. 2) observes, this is a "*challenge for outcome-based infrastructure — a challenge the existing orthodoxy will have to overcome to deliver the desired outcomes*." Furthermore, it is arguable that whilst specific to the relationship between comfort and a measure of road smoothness, the study begins to explore a much wider issue of the interrelationship between strategic intent and the management of infrastructure.

System-level implications

In their overview of governance research, Daily et al. (2003, p. 2002) observe that "*in nearly all modern governance research, governance mechanisms are conceptualized as deterrents to managerial self-interest*". This points to an intrinsic conflict with both public administration and with the nature of infrastructure itself. A conflict that New Public Management and service-oriented philosophies aim to reconcile for public sector organisations.

The work by Kaplan and Norton (1996, 2004), and their development of a balanced scorecard approach to reconciling strategy and operations, also attempts to frame this issue. However, as Norreklit (2000, p. 67) observes, this is focused on the establishment of measures and, citing de Haas and Kleingeld, "*invalid assumptions in a feed-forward control system will cause anticipation of performance indicators which are faulty, resulting in dysfunctional organizational behaviour and sub-optimal performance*".

However, whether the balanced scorecard, or indeed any other framework for strategic/operational alignment is appropriate, is academic. This is because of the lack of feedback mechanisms that exist within infrastructure management (Busby, 1998; Flyvbjerg, Skamris Holm, et al., 2003; Lenferink, Tillema, & Arts, 2008). Consequently, tools (such as those proposed by Kaplan and Norton or Osterwalder (2004)), whilst perhaps useful, arguably apply to the operation of infrastructure as a business unit, not the services derived from, and therefore the performance of, the infrastructure itself. This remains a continuing theme in infrastructure delivery (e.g. Controller and Auditor-General, 2010, 2014; Dobbs et al., 2013; Institution of Professional Engineers New Zealand, 2010).

Additionally, if Ackoff (1971) is correct in the assertion that complex systems (such as infrastructure) exhibit dynamic, goal seeking behaviour, the relevance of output- and outcome-based performance measures is called into question. By contrast, assessing the *attributes* of services at the systems-level of assets, networks, and social context may well provide a more suitable approach (proposition 2).

Although this study has usefully highlighted an immediate issue with one commonly used road infrastructure measure, it has also provided an insight into the wider alignment of infrastructure management with strategic intent. The complexity of the social–technical interface calls into question the applicability of current management approaches when applied to system-level services (rather than the business unit of the infrastructure organisation itself). It is suggested that this is an important distinction and this broader system-level issue remains an area where further infrastructure-related research is required.

7.5 Detailed study 3 conclusions

Approaching the strategic objective of delivering customer comfort through a different lens has served to highlight not only the inherent complexity of the notion of comfort itself, but the need to adopt a more holistic approach. The study has highlighted the importance of effects on vulnerable users, reconciling user need, and in considering both footpaths and the road cross-section. Whilst some might argue that this is not the primary focus of road, and less so highway engineers (and there may be jurisdictional boundaries that reinforce this), it was the vulnerable user and non-vehicular modes that were of greatest importance to the actual customer despite the predominance of vehicular access and use amongst participants. Furthermore technical, contract, or jurisdictional boundaries appear to be of little relevance to the customer. A summary of the key points from the deep dive are provided within Table 7.1.

Table 7.1: Summary of the performance management deep dive

Operations—strategy transition: Performance management (NZ Transport Agency)	
How is the misalignment being generated (what are the reasons for the misalignment)?	
Workshops	▪ Terminology and the range of given issues often assumed — can be irrelevant/have different meaning to customers. ▪ Focusing on technical issues too early curtails meaning/learning. ▪ Embedded belief-system inhibits inquiry. ▪ Organisational, contract, and administrative boundaries are irrelevant to customers. ▪ Monitoring inherently assumed to contribute to strategic intent. ▪ Face-to-face customer interaction around needs rare.
Survey	▪ Don’t usually ask potential/new customers. ▪ Don’t target all customers (reflect technical/mode bias). ▪ Don’t survey beliefs or reflect the complexity of an issue. ▪ Satisfaction is a sliding scale and does not necessarily enable change, correlation to conditions/context, enable the system to evolve/learn.

Operations—strategy transition: Performance management (NZ Transport Agency)	
	▪ Customers have different needs in different contexts and over time — current approaches over-simplify.
Effects	
▪ Does not provide for all/future/new customers. ▪ Particularly does not provide for vulnerable customers. ▪ Does not reflect multi-functional assets or the multiple services provided by those assets. ▪ May address how customers feel using the asset — but does not consider how the asset serves their lives (confuses interaction with an asset with enabling societal outcomes). ▪ Many effects unknown/hidden as not measured. ▪ Does not reflect the complexity of outcomes such as improved comfort. ▪ Does not support strategic intent. ▪ Does not enable meaningful feedback/feed forward to strategy (or projects and operations).	
Implications and interventions	
▪ Technical practice needs to evolve to reflect changes in context (e.g. society, technology). ▪ Care is needed so that all customers are heard; particularly the vulnerable. ▪ Not all outcomes are equal — technical outcomes are not the same as system outcomes. ▪ Changing KPIs alone insufficient — systemic change required. ▪ Outcomes may not be enough — measures need to include system aptitudes. ▪ Feedback needs to feed forward. Monitoring needs to generate information (not data) to enable the system to evolve.	

Whilst New Zealand specific, it is expected that the findings of this study will also be of general relevance and use elsewhere. It shows:

- The customers' concerns do not appear to match the current engineering or technical focus:
  - the customers placed greater emphasis on a range of different factors and in relation to road smoothness were more concerned with the road cross-section;

- footpaths and crossing transitions appear to play an important part in overall customer comfort. Pavement-related matters reinforced issues with trip hazards, but also identified the importance of pavement width (the ability to socialise, navigate, and share);
- customers identified the need for designs to both evolve to accommodate new modes (e.g. mobility scooters), but not to the exclusion of others (e.g. the smoothing of radii which makes cornering in a vehicle better but makes speeds difficult for pedestrians crossing the road);
- there was a feeling expressed that many of the effects on vulnerable groups were not as readily apparent (and without diminishing the impact) as say a death or serious injury on the road.

▪ Customers do not neatly aggregate or respond as modal groups. There are a range of user groups that give an added complexity across many modes, and customers view the issues across all their modal choices and experiences. This includes their interactions with other modes.
▪ There is a need to widen or change the lens being applied to performance indicators or other measures, to check that they are delivering the intended outcomes from the perspective of those they are intended to benefit. As indicators are never a complete measure, it is crucial then, that these are supported, augmented and reviewed so that the reason or outcome does not become secondary to the measure.
▪ If infrastructure organisations are to truly give effect to outwardly-focused strategies, such as customer outcomes, then changes are likely to be needed to align current practice with strategic intent. This may include changes to technical specifications, and contract boundaries (for example). This is likely to require further consideration of how conflicts between user groups and modes, as well as technical matters, may be better reconciled. Attention also needs to be given to less tangible aspects such as organisational belief-systems and aptitudes. These may not make up many of the issues, but can have undue influence on the effectiveness of any change.
▪ Any changes to orient technical practice with customer outcomes, is also likely to require inter-organisational or industry alignment. For example, in New Zealand, NZTA practice has interfaces with local government, AustRoads, and central government reporting.

This study has provided a rich source of information and insight into customer needs, and how this interfaces with organisational drivers and technical performance. It has underscored the points that:

- the notion of comfort is indeed complex; and
- whilst performance indicators are a useful management tool, it is important not to wholly rationalise measures to fit technical requirements or preference.

It also underpins the need to manage infrastructure to achieve not only satisfactory customer outcomes from direct contact with the asset, but to also outcomes that improve the way in which the asset affects society's needs and aspirations. If outcomes-based infrastructure management, and in particular customer-centric strategies are to be adopted, then not only do these need to be supported through a more holistic philosophy, this may require a revision to how these are fundamentally approached in practice.

8 Summary of Detailed Studies

To date, there has been little systematic research on the relationship between* [public service] *governance and performance. Debate is driven by theoretical propositions and individual case examples rather than an integrated corpus of empirically based knowledge.

Skelcher (in Hartley et al., 2008, p. 28)

Part II has presented the results of three detailed studies undertaken as deep dives through key lifecycle interfaces within the land transport sector of New Zealand. This was to investigate how the misalignment between strategic intent and the management of infrastructure systems is being generated (Table 2.1). The detailed studies were not intended to cover all aspects of the system, or indeed the infrastructure industry, sector, organisation, but to probe this through different lenses (Chapter 4). Crucially, this also involved slicing vertically through current practice from first principles; an approach found to be necessary in effective strategic diagnostics and change (e.g. Bessant & Stamm, 2007; Dobbs et al., 2015; Horwath, 2009). In so doing, the studies enable an integrated picture of systemic issues and performance to be developed (Part III).

The detailed nature of the studies was also aimed at assisting practitioners understand that there is a problem by presenting this from a position of technical familiarity and evidence (rather than policy-driven directives).[103] In other words, to show how system-level problems manifest themselves in real terms within current

[103] Yankelovich (1991); Yankelovich and Friedman (2010). See also Table 2.1: ‘clues’ and ‘analogies’ (Davis, 1971).

technical and tactical practice. This is particularly relevant for areas of practice that are well-established and engrained (such as the road smoothness performance measure; study 3), but equally serves as a cautioning opportunity in emergent areas (e.g. system-level benefit management; study 1).

A number of contributing factors had previously been identified in the preliminary research (Table 3.1).[104] As was expected, the detailed studies encountered these (summarised in Table 8.1). These wider factors contribute to the 'learnings' arising from this research and point to opportunities for further process improvement. Similarly, the preliminary research identified key reasons why infrastructure did not perform over the long term (Section 3.4). The detailed studies provided examples to support these, which have been integrated within the cross-case analysis (Chapter 9).

Table 8.1: Detailed study intersection with contributing lifecycle factors

**Denotes matters where the deep dive investigated this factor in detail, so no further summary comment has been made.*

Contributing Factor	Comment
System benefit management	
Articulating benefits	Study 1 investigated this from three angles: connectivity of strategic objectives, visibility of benefits at the governance level, and how benefits were being managed within project delivery (see Sections 5.3.1-5.3.3, Appendix VI).*
Business case boundaries	Encountered in Sections AVI.2.2 and AVI.3.1, highlighting matters with the transparency of approvals processes, and of the BCRs contained therein. The latter being particularly important as the bundling of benefits did not enable benefits to be understood, managed, or audited (nor compromises or dis-benefits in other areas to be understood).

[104] These were identified within the preliminary research as lifecycle interface factors (topics of interest) and should not be confused with matters that characterise the system.

Contributing Factor	Comment
	Also encountered within study 2 (Sections 6.3.1-6.3.2, and AVII.1.1-AVII.1.2), where business case-thinking was found to be 'overreaching' and impacting on operational processes (e.g. omission of long-term operational costs from cOPEX). The information contained within the business case was not being updated as works progressed and no *ex ante* assessment was conducted to inform future processes.
Lock-in/ momentum/ prioritisation	This was encountered in everything from salience — who or what was being prioritised within the system (Sections 5.3.1 and AVI.3.3; this study, and Sections 6.3.2 and AVII.1.1) — through to process and institutional lock-in arising from incremental improvement, embedding of benefit assumptions, through to effects arising from the absence of feedback (Sections 5.4.2 and AVI.1.1, AVI.2.2, and AVI.2.4-AVI.2.5). Similar matters were found in study 2 (Sections 6.3.2 and 6.4.2) and was the underpinning basis of study 3 (which explored a well-entrained industry metric in road smoothness; Chapter 7).
Follow-through/ reconciliation with system-level objectives (feed-forward)	*
Whole-of-life management	
Handover (feed-forward)	*
Transition from asset to system	*
Whole-of-life performance	*

Contributing Factor	Comment
Performance management	
Performance (benefit) monitoring	Study 3 investigated this from the customer perspective (since this was how the strategic intent had been articulated in this instance).* Benefit monitoring was also encountered within the other studies (see elsewhere within this Table).
Follow-through/ reconciliation with system-level objectives. Feedback to strategy	*

The detailed studies have also shown areas of systemic practice that are having a material effect upon long-term outcomes. However, those effects are not often visible to the system itself; being acts of omission rather than commission. This is being ‘aided and abetted’ by the misconstruing (whether intentional or not) of outputs and technical outcomes as infrastructure outcomes which, by definition, must be externally-oriented services. Infrastructure is important, not because it exists as a physical feature, but rather because of the critical services that it should provide.

PART III: SYNTHESIS

Are the strategic intent and the day-to-day management of infrastructure systems misaligned, and does this have negative consequences for achieving the desired long-term infrastructure system outcomes?	
Part I: Context	Is there misalignment, and how is this recognised as a problem within the wider infrastructure industry? What are the stories?
Part II: Detailed studies	How is the misalignment being generated (what are the reasons for the misalignment)?
Part III: Synthesis	**What characterises this misalignment or 'gap'? Given this, what are the implications, if any, for infrastructure administration and long-term infrastructure outcomes?**

Part III of this research synthesises the results of the three 'deep dives' to now consider the relationships between these and the implications (if any) at the system level. This is aided by cross-case analysis of themes from the detailed studies. The overarching conclusions then consider the methodological aspects of this research, reflect upon the practical and theoretical contribution of this research, and summarise the research findings.

9 Cross-case Synthesis and Discussion

Several years ago, Institution of Civil Engineers president Paul Jowitt (2010) observed that a more holistic and inclusive approach to infrastructure was required. He argued it was the time to reorient civil engineering practice back towards its imperative: that of delivering societal benefits. This research shows that not only are such outcomes still being compromised (and ways in which this occurs), but that:

- Outcomes are being eroded despite a growing awareness amongst practitioners of the need for a more holistic approach.
- The problem cannot simply be explained away as poor organisational, sector, or country performance.
- Projects are not well-integrated into operational infrastructure systems. Irrespective of any ability to deliver project benefits, there are fundamental problems within day-to-day infrastructure administration that affect the ability to deliver the intended long-term benefits.
- A different approach was required to better understand, and then deliver, long-term infrastructure outcomes.

This, then, was a significant research opportunity as the application of theory to the practice of aligning strategy and operations is largely unexplored, and the study of whole-of-systems, emergent (Jackson, 2009a).

This research has investigated key leverage points (Bosch et al., 2013) identified by industry at this time. It provides different perspectives by using three 'deep dives' through process, organisation, and sector (as well as longitudinally across the lifecycle itself). This enabled issues to be tested from first principles and matters triangulated to give a picture of the matters that characterise and shape the misalignment or 'gap' (Table 2.1). This Chapter presents the results of the cross-analysis of those deep dives, and as such, integrates the findings of the earlier detailed studies.

9.1 Matters that shape and characterise systemic misalignment

In addition to highlighting the importance of lifecycle interfaces, the preliminary research interviews identified a range of related factors (Table 3.1); which were subsequently encountered in more detail within the deep dives. However, those factors related to processes or practice areas. They do not, in themselves, necessarily transcribe the relationships between the detailed studies or the system-level stories that might enable the identified gap between the strategic intent and management of infrastructure systems to be characterised.

To deduce the overarching themes, the results and case-specific thematic outcomes from the detailed studies were categorised and sorted alongside those from the preliminary research (Ryan & Bernard, 2003; Section 4.4.2). This resulted in four interrelated themes:

- Bounded influence, which is shaped by four aspects:
  - organisational structure;
  - strategic reach;
  - transfer dimensions; and
  - salience.
- Business practice.
- Feedback.
- System stewardship.

It is these matters that contribute to, and characterise, the gap between the strategic intent and management of infrastructure systems.[105] Each of these is discussed in turn below.[106]

9.1.1 Bounded influence

Each of the detailed studies explored an infrastructure lifecycle transition or interface. ‘Handover disconnects’ are a well-known problem (Chapter 3), and current convention is that the transitions are unidirectional (Figure 1.1). Handover dysfunction is often seen as solvable by checklists and data transfer, and obviously this may work well in certain situations. However, the studies have shown that not only were all of the researched lifecycle interfaces complex and multi-directional,[107] they were further complicated by layers of what will be termed ‘bounded influence’.[108] Here, bounded influence refers to matters which limit influence and the ability to implement the change necessary to effect the intended outcomes.[109]

---

[105] There will be others, as the approach adopted here is a probing one. However, it is not so much what these matters are, but rather what they tell us — the stories they bring — about the wider system, its functioning, and the outcomes that are possible (or in this instance curtailed) as a consequence.

[106] This section includes cross-references to the preceding sections of the thesis to show where examples that support the assessment may be found. This is not a proxy cross-case assessment. As with the rest of the document, examples have been given to demonstrate a point or a cross-connection.
Note: Headings and captions within appendices are numbered A[appendix number].[number]; e.g. Section AVI.1 is within Appendix VI.

[107] Different parts of the system are at different lifecycle stages, and multiple projects or operations may be affecting a given part of the system, and these will be simultaneously acting on the interface.

[108] See Bourne and Walker (2005) and Pfeffer and Salancik (2003).

[109] The willingness, capability, and/or capacity to effect that change is a separate matter (see Section 10.2.2).

Both study organisations reflected on the complexity of the matters to be addressed at each interface if the effectiveness of lifecycle transitions were to be improved; firstly to correct and adjust existing practice, and secondly to continue the process of learning and adaptation as the system evolved. The organisations also signalled the complex and multi-dimensional nature of the interfaces were also challenging current perception and mental models.[110] It is one thing to know something is complex, and quite another to see where one can direct, influence, or merely observe.[111] It is also important to understand what is being omitted as a consequence of an overly simplified transition or response. This is analogous to putting theory into practice in that it must be "*seeded by a real-life problem that is worth solving*" (Madhavan & Mahoney, 2011).

Organisational structure

The effect of organisational silos is also well recognised, and often focused upon the project–operations interface (Chapters 3 and 6). However, study 2 in particular, challenged this by highlighting disconnects created by the relative ease at which the primary functions are, in fact, identifiable silos. To this end, whilst the capital development part of the study organisation was complex, 'the project' was typically a known or identifiable team. However, in reality, '*operations'* was not as neatly identifiable as it comprises multiple functions.[112]

This raises a number of fundamental questions:

- Who or where within the organisation was 'the project' to be handed to, and who was accountable for the outcomes (including co-ordination and integration with other newly delivered capital works)?
- Who was accountable for that process? Was this capital development given the tendency to close a project shortly after close of contract, and/or was there an

[110] Sections AVI.4, 7.4.1, AVIII3.2.

[111] Figures 6.1-6.2, AVI.5, AVIII.19.

[112] Sections 7.4.3, AVIII.1.1, AVIII.1.3-AVIII.1.5.

individual in operations (given the need to follow the 'threads'[113] through the organisation)?

- Who subsequently 'owns' those threads, where they are stored, and what value they are given over time (or when they are lost)?
- Who, then, was responsible for providing integrated operational feedback to those developing strategy, or was the customer/user voice on a project?

Historically, many of these issues have been managed through tools such as an asset management database. However, as complexity increases and infrastructure is re-purposed, such tools are no longer adequate on their own, have become a proxy for decision-making, and enable the abrogation of responsibilities (e.g. Section 5.4.1).[114] This was visible in all three studies, but was particularly demonstrated by the limitations of current cOPEX estimating practice[115] and the use of an overly simplified performance measure (road smoothness) as an indicator for strategic intent (improved customer outcomes; customer comfort).[116]

Furthermore, such a simplified view of operations is problematic in large organisations, where 'operations' consists of multiple departments and functions including multi-modal services.[112] In this regard, detailed studies 1 and 2 also demonstrated that effective change or ongoing implementation was not simply a matter for the asset management team and that delineation according to organisational structure, system tools, and/or processes does not account for all requirements.[117] Instead, the 'threads' need to be firstly defined and understood and then followed through the organisation to their logical conclusion. This is inclusive of any consequences (secondary threads) generated by that process.

---

[113] e.g. strategy, benefits, compliance or other requirements, levels of service, standards.

[114] Seddon (2008) cites similar problems with the reliance on tools by UK public services, noting that "*to codify method is to impede thinking*" (Ibid., p.68).

[115] Chapter 6.

[116] Chapter 7.

[117] Benefit management: Sections 6.4.3, 6.4.5, AVI.2.4; cOPEX: Sections 7.3.1, AVII.1.

Moreover, because public infrastructure organisations can best be viewed as a complex adaptive system, this is (necessarily) an ongoing and evolving process.

Infrastructure only exists as a project for a very short period of its lifespan. Post-delivery, it disperses across and is absorbed by the physical and organisational system.[118] The transition is perhaps less about project to operations, than project to system. This is where the notion of system stewardship developed within study 1 has merit (Section 5.4.1).

We're bringing together **[…]** ***literally dozens of disparate systems that have not been designed to*** **[…]** ***work together or invested in, as a coherent collection of networks. So we are having to get to grips with*** **[…]** ***different pieces of infrastructure, not necessarily aligning nicely with*** **[…]** ***the way the network is operated*** **[…]** ***we're still probably adding operating costs that we would be better to avoid. And*** **[…]** ***I'm not being critical of what we're doing*** **[… … but]** ***we've got quite a bit more*** **[…]** ***to achieve.***

[PR19]

✓ **Proposition 1*:*** *Individual infrastructure projects automatically, by their nature, become part of, are embedded in, and change, a complex infrastructural system (e.g. interactions, feedback, emergent properties).*[119]

---

[118] This was apparent within study 2 with the way in which the cOPEX schedule was developed, its interface with other operational departments (e.g. public transport/AT Metro), maintenance contracts and compliance (amongst other matters). Section 7.3.2, Appendix VII.

[119] This is the first of the three original research propositions outlined within Section 2.1. It should be noted that the themes within this section are (as with all the themes in this research), intertwined. These boxes have been located as closely as practicable to an applicable point. Other supporting statements/examples may also be found in other parts of the discussion.

Strategic reach

Currie and Proctor, (in Walshe et al., 2010, p. 251) advise that:

> *Although the public sector literature is giving increased attention to strategy, there have so far been few explanations about how public sector managers develop and implement new strategic approaches.*

Whilst study 3 investigates the implementation of a new, customer-oriented strategy (NZTA, 2014a), it was study 1 which charted the development of the strategic framework of a newly formed infrastructure organisation, through to project delivery, and, through study 2, to operational implementation. This showed that the effectiveness of strategies was being curtailed from their formation.[120]

As one delved deeper into the organisation and wider industry, the impediments to the delivery of strategy kept building. Study 2 demonstrated the significant role played by handover omissions and other systemic disconnects.[121] All studies found that, in general, outcomes relating to existing organisational processes or tools were more likely to be retained than:

- Complex/non-standard assets (e.g. architectural features).
- Long-term requirements (e.g. maintenance for long-design-life structures).
- Those relating to:
  - how the infrastructure enabled society (e.g. provision for local place-making, customer comfort); or
  - its context (e.g. environmental mitigation or enhancement).[122]

There was a sense of society working around its infrastructure, despite the strategic intent of the infrastructure organisations responsible for its management.[123]

---

[120] Sections AVI.1, AVI.2.1.

[121] Sections 7.4.1, AVII.1.

[122] Sections AVI1.5, AVI.2.5, 7.4.1, AVII.1, AVIII.1.2, AVIII.2.2.

[123] Section AVIII.1.2.

Whilst the subject organisations showed a broad awareness of their overarching strategic direction, generic strategic justifications in organisational processes and documents also led to disconnects, or strategies being reinterpreted by different parts of the business.[124] This led to the partitioning of outcomes by functional area and compounded the barriers to the organisation as a whole aligning with its strategic intent.[125] Certain strategies appeared to be favoured over others because they might have sustained a convention or 'belief-system'. Others have also encountered this. For example, in relation to study 3 (Controller and Auditor-General, 2010, p. 36):

> *NZTA has a detailed set of technical levels of service and overarching performance targets and measures for maintenance and renewal work. But it was unclear how these levels of service were determined, or what they mean for road users* [... …] *NZTA's overarching levels of service for pavement maintenance were inherited* [...] *and have been in place for many years* [... …] *It told us that these* [...] *are comparable with those of overseas roading authorities.*

Accordingly, this also serves in underlining the importance of the deep dive from first principles (Dobbs et al., 2015).

Study 1 found that the organisation was well-connected to some strategies whilst others had been completely omitted without documented justification: strategic connectivity by preference, not plan (Section AVI.1). This raises the issue of who decides which factors are most important, and what is to be omitted, particularly where there are democratic and statutory processes that call for transparency and invite public participation in the decision-making. This, in turn, affected board reporting, leading to study 1 asking "*If not the board, then who is responsible for closing the system-level strategic loop?*" (Section AVI.2.2).

---

[124] Sections AVI.1, AVI.2.5, Appendix VIII.

[125] Chapter 6, Section AVI.2.3.

Detailed studies 1 and 3 highlighted the importance outcome-oriented performance plays in affecting strategic reach.[126] However, not all outcomes are equal. This point was made in study 3 (Section 7.4), whereby outcomes need to be directed at two levels:

- how an individual interacts with the asset (e.g. they have a pleasant experience, and don't feel unsafe or vulnerable); and
- how the infrastructure enables that individual's life/business (they can do what they want to, when they want to).

Many of the performance 'outcomes' encountered during this research were focused on the first of these. This might provide valuable information on maintenance and asset performance, but is ultimately introspective and may not necessarily align with community expectation or need. Rather, technical requirements are system-level outputs, not outcomes (see also Seddon, 2008). This touches on two further matters that bound, or limit, influence: transfer dimensions and salience.

Transfer dimensions

In study 3,[127] analysis of all the workshop material showed effecting change was a matter of:

- **Needs**: What is delivered and how it is delivered.
- **Precepts**: What customers believe or expect to be delivered.
- **Choices**: Whether the choices are appropriate, purposeful, and that compromises have been understood.[128]
- **Aptitudes**: Whether there is the ability to change both reactively and proactively.

[126] Sections 6.4.5, AVI.1.3, 8.4.

[127] Section AVIII.3.2.

[128] This differs from the issues raised by Seddon (2008) with the provision of customer 'choice' in the public sector.

- **Process/technical requirements**.
- **Institutions/entities/functions**.

The first four of these had been firstly identified as 'problem dimensions' within the preliminary research, and were subsequently found to affect how problems were being understood by the organisation within study 1 (Section AVI.2.5).

It emerged from study 3[129] that whilst responding to existing requirements (needs) or processes might be an obvious and relatively straightforward option, there were secondary areas that, due to their disproportionate influence, would have to be addressed if change was to be effective. Attending only to existing function, need, and/or process was likely to curtail the effectiveness of the project–system transfer and amalgamation.

By contrast, study 2 identified a slightly different range of factors and proposed a whole-of-life change matrix (Figure 6.3) as a result. Although aimed at effecting change across the infrastructure lifecycle (***'lifecycle change'***), and also to account for ***organisation change*** requirements, there was nonetheless overlap with the preliminary research and the other detailed studies (e.g. process, organisational belief, structure, function).[130] Furthermore, all the dimensions/factors encountered across the research programme were found to reinforce disconnects with strategic intent through omission, organisational inertia, and factors such as redirection/reinterpretation. Therefore, to effectively transfer a project into an operational infrastructure system, whilst retaining the intended outcomes across the infrastructure lifecycle, change processes need to address the organisational, lifecycle, and wider contextual outcomes that are the imperative of infrastructure (***'contextual change'***).[131]

[129] Section AVIII.3.2.

[130] Sections 3.2, AVI.2.5, AVIII.3.2.

[131] The highlighted text is returned to in Section 10.1.4; notably these terms appear as dimensions of change within Figure 9.1.

Salience

The detailed studies highlighted a range of salience-related factors,[132] for example:

- the ability of customers to be ‘heard’ over technical and funding considerations;[133]
- the voice of the vulnerable customer;[134]
- relative performance and levels of service between areas and modes;[135]
- ‘best for project’ over operational and system-level considerations;[136]
- control, responsibility, culture, and familiarity/convention;[137]
- perceived personal relevance/interest (e.g. introspective outcomes, disciplinary background);[138]
- the relative level of attention given to tasks related to performance measures;[139] and
- visibility of an issue.[140]

It was the first two of these matters that are perhaps of the greatest importance.[141] Whilst study 3 explored this matter directly and in the most detail (Chapter 7), the issue of stakeholder, community, or customer salience was a recurring theme throughout all detailed studies and the preliminary research interviews.[142]

---

[132] Defined in Section 3.2.

[133] Sections 3.2, 6.4.3, 8.4, AVI.2.2, AVI.2.5, AVIII.1.2 AVIII.2.2.

[134] Section 6.4.3, 8.4, AVIII.1.2, AVIII.2.2.

[135] Sections 6.4.1, 6.4.2, 7.3.2, AVI.1.3-AVI.1.4, AVII.1.3, AVIII.1.2, AVIII.2.2.

[136] Sections 7.3.2, AVII.1.1.

[137] Sections 3.4, 6.4.1-6.4.3, 6.4.5, 7.4.2, 8.4, AVI.1.5, AVI.3.2, .AVII.1.1.

[138] Sections 3.4, 6.4.3, 7.3.2, AVII.1.1.

[139] Section 3.4, AVI.1.5, AVI.2.2-AVI.2.3.

[140] Sections 6.4.1, 6.4.2, 6.4.5, 7.3.2, and AVI.1.2, AVI.1.5, AVI.2, AVII.1.1, AVII.1.3.

[141] Relative to the meaning of infrastructure and public administration (Sections 1.1 and 2.3).

[142] Sections 3.2, 6.4.1, AVI.3.3, AVII.1.1.

Worryingly, the inclusion of customers as active participants is deemed ‘unorthodox’ for industry (Moodley, 2015).

Bonsall et al. (2005) noted that few customer surveys and studies considered customer beliefs. Study 1 picked up this theme by recommending the inclusion of a belief-oriented performance measure to assist the development and assessment of customer-oriented outcomes (Section 5.3.3). The study also highlighted the lack of customer voice during the operational phase to protect or argue for the retention of outcomes or levels of service (Section 5.3.3). Given the requirement for community participation in the study context, this was not so much about higher-order community consultation, but where or who within this amorphous area of ‘operations’ was the proxy for the customer voice (and which customers were being ‘heard’ the most).

9.1.2 Business practice

Failure to account for the lifecycle and context dimensions of infrastructure was shown to impact on the ability to deliver appropriate outcomes in all three of the detailed studies.[143] Accounting convention (study 2) was particularly problematic with issues ranging from the over-reaching of investment assessment tools (e.g. use of BCR parameters or discounting in the assessment of long term requirements and costs), through to budgetary horizons, and the management of non-standard/complex assets/services (Section 6.3.2, Appendix VII).

Hussein and Hafseld (2016), too, describe a range of organisational influences encountered by a governmental project in Norway. Many of the issues raised, such as culture, human resources frameworks, change management, and user involvement are issues-in-common with this research, which found these can create a form of ‘running interference’.

The point is, improved co-ordination, incremental improvement/establishment of best practice is unlikely to be sufficient and may result in perverse outcomes. Just as engineering and other technical processes may need to change mental models

[143] Sections 6.4.3, 7.3.2, AVI.2.2, Appendices VII-VIII.

and orthodoxy to provide better alignment with customer- and system-level outcomes (i.e. efficacy), business practices do too. This is an area for further research and development for the relevant sectors.

9.1.3 Feedback

The wider industry interviews and subsequent detailed studies found that benefits (infrastructure outcomes) are:

- often being deferred or are not being followed through during project delivery;[144]
- rarely followed up and reassessed post-project delivery;[145]
- frequently not following on within the wider operational system;[146] and
- mistaken for technical and/or administrative measures during both operations and project delivery.[147]

This affects organisational memory as the information is not available to feed forward into the incremental development and the evolution of strategy (Thiry & Deguire, 2007). Ackoff (1971, p. 665) observed that if a goal-seeking system has memory, then "*it can increase its efficiency over time in producing the outcome that is its goal*".

Where feedback was encountered in this research, it was generally found to be in the realm of incremental improvement (Figure 1.2). Such feedback is introspective — little more than a lessons-learned exercise aimed at the project level — useful, but not all that is required from a system perspective. The reduced scope and project-level specificity reinforced retrospection and a perceived or actual reduction in wider applicability:

[144] Sections 3.4, 6.4.3, 7.3.2, AVI.3, AVII.1.3, Appendix IV. Note that the 'follow-through of benefits is not just a matter of completing a project checklist. This is also a matter of (for example) resolving conflicts, delivering consequential actions/requirements, and ensuring services and operational matters are provided for and handed over.

[145] Sections 3.4, 6.4.2-6.4.3, AVI.2.1-AVI.2.3, Appendix IV.

[146] Sections 6.4.3, AVI.2.3, Chapters 6-7, Appendices VII-VIII.

[147] Sections 6.4.2-6.4.3, AVI.2.1, AVI.2.3, AVI.2.5, Chapter 6.

- Because an infrastructure system consists of assets, projects, and networks at various stages in their lifecycle, an end-of-pipe expectation of feedback is neither practicable, nor likely to happen, because:
  - of the time scales involved;
  - of the existence of silos, not only within the infrastructure organisation itself, but within its consultant teams, who may specialise in one particular stage of infrastructure management (e.g. scheme assessment and consenting versus detailed design or construction supervision);
  - infrastructure is a chaordic system (Olmedo, 2010; Snowden & Boone, 2007); and
  - there is not, in fact, an end to the process as a project may be one of many that are simultaneously acting on an infrastructure system.
- Not only is there a need to feed back between lifecycle phases, but there is also the need to do so between the organisational levels of strategy, operations and tactical management.

This is where the depiction of feedback processes (such as that shown in Figure 1.2), can be problematic as they do not incorporate the ongoing change to a system that occurs independently of any transformative feedback. This is not just a matter of graphics. Rather, this was found[148] to be more indicative of how feedback was both being thought of, and thence managed, in practice. Whilst Figure 1.2 shows two additional levels of feedback and learning, there is yet another (complementary) way to look at this. This is that, quite simply — but paradoxically — when viewed as a dynamic and evolving system, feed-back actually feeds-forward and contributes to systemic change.[149]

[148] In the preliminary research interviews, subsequent detailed research discussions/interviews, and also within reviewed documentation.

[149] This includes enhancing organisational learning. As study 3 found, this is vital given the changing technology and complexity of infrastructure.

At face value, this might seem at odds with Snowden and Boone (2007).[150] But feedback/feed forward is not the same as foresight, and both need to be accommodated and reconciled; for unless feed forward occurs, strategies are at risk of redundancy without this necessarily being immediately clear. This is particularly so, given the chaordic nature of the system (Section 1.1). Accordingly, infrastructure administration needs to be re-oriented to system-level matters.

✓ **Proposition 2:** *The governance and management of such systems will not be effective if focused on outputs at the level of projects, assets, or even subsystems. Governance and management needs to address the desired/intended strategic, externally-oriented outcomes and aptitude of the whole system. They also need to address the contributions of individual projects and of the day-to-day operations to that system.*

9.1.4 System stewardship

The 'better use of existing assets',[151] as a first step towards improved infrastructure outcomes, is not just a matter of asset management. It is enabled by both managing the transfer and system assimilation of new projects/renewals and services (studies 2 and 3), and the ongoing stewardship of customer-oriented benefits over the long term in a continually changing system and its interrelated context (all studies; see previous Section).

Change management in the context of an infrastructure system has been discussed already as has the importance of feedback as a feed-forward mechanism. The latter was highlighted by studies 1 and 3 and in particular the role community engagement and collaboration played in that feedback/feed-forward flow. However, providing an integrated operational response can be challenging

[150] *"Since hindsight no longer leads to foresight after a shift in context, a corresponding change in management style may be called for."* (Snowden & Boone, 2007, p. 2).

[151] This is a directive that supports several current strategies; from those of the subject organisations (e.g. Auckland Transport, 2015b), New Zealand land transport directives (e.g. New Zealand Government, 2011a), the global infrastructure review undertaken by Dobbs et al. (2013), through to core asset management principles (e.g. NAMS, 2011).

when ‘operations’ is, by contrast to a project’s delivery, a diverse group of autonomous functions.

During the preliminary research interviews, it was observed that roles such as that of the borough engineer (who had oversight of the infrastructure of an area) no longer exists.[152] As the system increased in complexity, this has, through necessity, increased specialisation. So as a consequence, this specialism created a barrier to systems-thinking. The ‘glue’ within the organisation and/or the system had been lost, and any connection to “*social advancement or social improvement”* had also gone missing [PR51].

Whilst all studies highlighted the need for silo-spanning roles, the effect of silos and specialisation was particularly noticeable in both studies 2 and 3 where benefits were being eroded by, for example, falling between decision-making boundaries, functions, or management processes and tools, or between management and governance (Chapter 3, Appendix IV). To respond to the issues raised within study 1, a model for system stewardship was proposed to reintroduce this system overview (Section 5.4.1).

Accordingly, the three dimensions of lifecycle, organisational and context-oriented change,[153] have been integrated with the notion of system stewardship and centred on externally-oriented outcomes (i.e. the customer). The aim is to provide a model for how the project-system transition and other system-level change might be improved (Figure 9.1).[154]

---

[152] Although the scale of that oversight was problematic as linkages to the greater system were lost.

[153] See ‘Transfer dimensions’; Section 10.1.1. This also reflects the required internal, external, and system-level foci identified within the preliminary research (Section 3.4).

[154] As such, this augments and extends the service-oriented framework proposed by Seddon (2008); a six step check comprising establishing the customer-oriented purpose, types and frequency of demand, system response to demand, system flow, system conditions, and management thinking. The model described by Figure 9.1 notably recognises the asset-as-service- requirements of the built infrastructure environment, and the role of the infrastructure

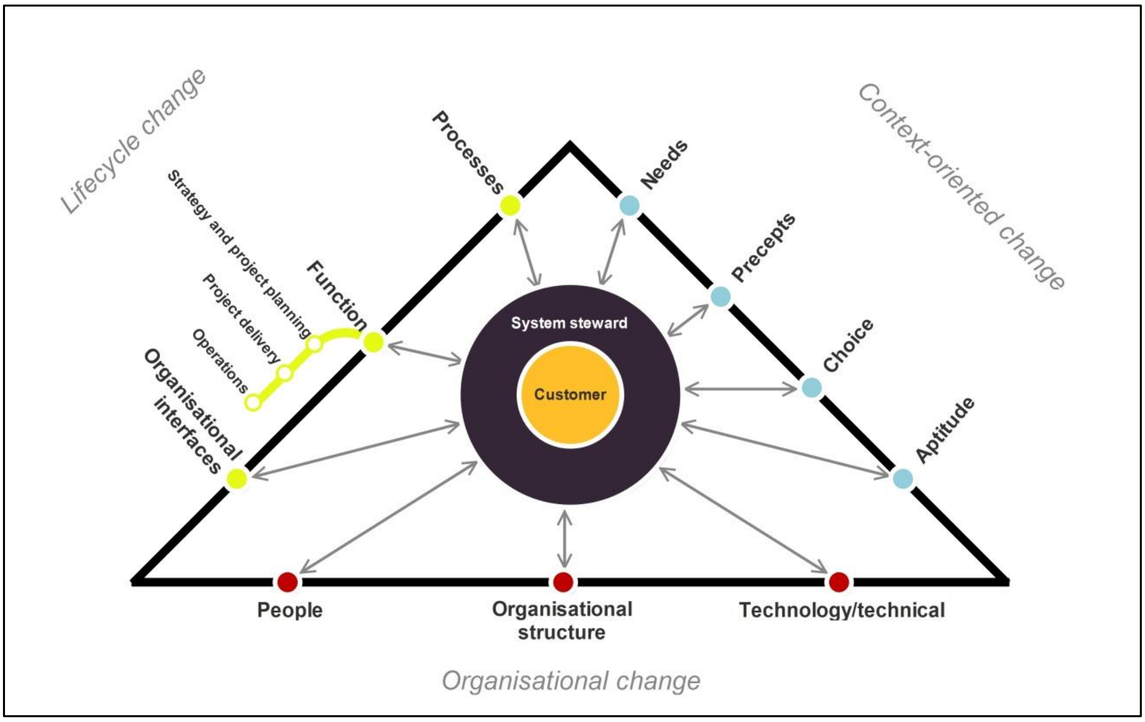


Figure 9.1: Infrastructure system change management model

This integration is important, but will inevitably require the balancing and management of requirements, or 'threads' through the system — and over time. This is not a unidirectional model, but provides for iteration and feedback/feed-forward. As such, this aims to give voice and visibility to customer-oriented outcomes (and synaptic-like system connectivity).[155] The model also provides a forum for reconciling and managing all the dimensions of change and system dynamics/evolution that appear, from the research, to be necessary to effect strategic intent. This research has shown that these integrated aspects are missing

---

lifecycle in shaping this. The two concepts are thus complementary, not mutually exclusive. It is noted that 'system steward' is an accountability (Section 5.4.1), so may be distributed across multiple functions, or established as a boundary-spanning role or group function on a case-by-case basis. It may also exist as part of an organisational culture or operational mode. However, the key point here is that there needs to be an accountability for integrating system-level outcomes and guiding the ongoing evolution of the system.

[155] Not to be mistaken for 'big-data' or more information, but rather learning and adaptive capacity.

from current practice with a resultant adverse effect upon long-term infrastructure outcomes.

✓ **Proposition 3*:*** *No matter how well individual projects are designed and delivered, or strategic outcomes are initially defined, systems are dynamic. Accordingly, infrastructure administration needs to both accommodate and continually respond to this time dimension.*

9.2 System-level implications

9.2.1 Implications for long-term infrastructure outcomes

The long-term implications arising from the management of infrastructure systems being unable to connect with, fulfil, or align with strategic intent are complex and interwoven with the four themes just discussed. Just as study 3 highlighted two levels of outcomes (inward and outward looking),[156] and all studies two levels of response ('corrective action' and ongoing system evolution and adaptation)[157] there are implications for infrastructure organisations *and* their environment.

By exploring the lifecycle interfaces (which provides a longitudinal profile and also explores organisational boundaries in this context), it is observed that strategic intent is not supported from the outset. Directives, objectives, and other statements of intent dissipate or become disconnected by strategy development. This is exacerbated across the project interface and project delivery where strategic intent can be adversely affected by project management drivers and 'best for project' thinking/behaviour (Chapter 5). Then, even if projects are able to fully develop and deliver upon the strategic outcomes being sought, there are subsequent milestone or key processes within the lifecycle of that infrastructure which inhibit its ability to:

- deliver upon the strategic intent (Chapters 6 and 7); and

[156] Section 8.4.

[157] Chapters 5-7, and explicitly discussed within Section 6.4.1.

- fully integrate and transform the system (as was inherently the intent of the capital works in the first place; see Chapter 1).

Many of the effects or implications of this arise from an insidious issue of omission and unrealised potential rather than acts of commission.[158] Furthermore, many of the negative implications are unlikely to be observable within the current conventions of an infrastructure organisation and therefore may appear as a 'latent failure' to that organisation. For example:

- **Asset life:** In the preliminary research, several 'legacy' issues were identified as arising from past infrastructure-related decisions and management choices (e.g. Section 3.5). However, every example referred to large-scale infrastructure that was less than a century old and therefore notionally within its design life. Examples included operational changes with unintended/unknown consequences (such as might be made to a water treatment plant) through to planned/purposeful deferred maintenance that knowingly reduces asset life. Whether purposeful or not, both are 'active failures' but may become absorbed or latent over time as that system knowledge is lost.

  Study 2 detailed this further (Section 6.3), showing a suite of active failures that included (amongst other matters) omissions and eroded levels of service. However, because the loss of asset life may not be known, or able to be tracked back to this root cause through organisational processes, a loss in asset life becomes a latent effect upon community levels of service (and potentially on rates or other levies). In other words, a latent social, environmental, and/or economic impact. Furthermore, all the studies suggest that even if the design life were achieved, the infrastructure may not necessarily have fulfilled its potential or delivered the intended benefits.

- **Social exclusion:** Study 3 showed (Appendix VIII) how parts of the community such as certain modes, sectors (e.g. rural), or user groups (in particular the vulnerable) are excluded or compromised by technical and organisational decision-making and processes. Furthermore, whilst organisational salience

[158] Sections 7.3, AVI.1, AVI.2.2, AVII.1.1-AVII.1.3, Appendix VIII.

and other factors may have led to this, the disparity or absence may not be visible to the organisation if those affected do not have a strong community voice to start with (social, cultural impact).[159]

- **Environmental impacts:** Study 2 showed (Section 6.3.2) matters of compliance including environmental mitigation and social outcomes were not being incorporated into cOPEX assessments. Should any adverse effects result, then these would not be seen by the subject organisation in this instance as there were no internal checks and balances at the time the study was undertaken (environment, social, cultural, economic impact).[160]

- **System fitness:** The preliminary research interviews highlighted resilience and related factors as top of mind for many infrastructure organisations. Study 2 also highlighted the omission of factors that might affect system ‘fitness’ (being aspects such as resilience, adaptive capacity, enabling future value).[161] These will likely only be observable to the organisation in retrospect, including after a major event such as a natural disaster (environment, social, cultural, economic impact).

Study 1 showed that it was not the strategic intent to exclude any of the above matters, in fact for the subject organisation, quite the opposite.[162] Yet that study showed that in order for long-term infrastructure benefits to be realised, more than a project-oriented benefit realisation process is required, that this requires the stewardship of our infrastructure systems; the feedback, feed-forward, and follow

[159] This was underscored in study 2 through the apparent lack of clear ownership for long-term operational matters, due in part to the diversity operational functions and therefore structure (see Section 10.1.1).

[160] This was also seen in study 1 with the weighting and preference given to traffic related benefits rather than to wider environmental and other aspects (see Sections AVI.2.1-AVI.2.2, AVI.3.2-AVI.3.3).

[161] Sections 7.3, 7.4.3.

[162] See AVI.1-AVI.2.

through at all levels of the organisation.[163] Moreover it requires not just the delivery of outcomes, but outcomes that are customer-oriented, and enable the goal-seeking behaviours of the complex, adaptive system that is infrastructure.

✓ **Hypothesis:** *The strategic intent and the day-to-day management of infrastructure systems are often misaligned, with negative consequences for achieving the desired long-term infrastructure system outcomes.*

9.2.2 Implications for infrastructure administration in practice

The preliminary research, followed by the three detailed studies, aims to bridge one of the gaps between theory and practice (Table 2.1). Although the individual studies considered areas in which there is often extensive existing research and practice guidance, a different approach was adopted so that every study:

- advanced both practical and theoretical knowledge and could be applied in its own right;
- continued to test the ability to fully deliver appropriate and relevant infrastructure outcomes over the long term;
- provided an evidence-base for why this might be so for each of the given examples (i.e. adds knowledge to underpin policy or industry/theoretical guidance and therefore the level of understanding; Table 2.1);
- contributed to the overarching problem both directly as a lens through which the overarching research question could be explored, and through the methodological approach.

Consequently, whilst much may be known about, say, asset management, this does not provide the whole picture. So whilst we might be familiar with the problems and/or some of the solutions, this research shows that there is more to the matter. Table 9.1 provides a summary of the broader applicability of the detailed study component of this research relative to the double- and triple-loop learning described in Sections 1.2 and 4.4. The summary draws upon preliminary interview material to assess the ability of the research to have wider influence.

[163] Sections 6.4.3, 6.4.5.

Table 9.1: Applicability of this research

	Ability to learn			Ability to influence			
	Single-loop: *Incremental improvement. No questioning of underlying assumptions*	**Double-loop:** *Revisiting the underlying assumptions of a normative framework*	**Triple-loop:** *Review of underlying values, belief-systems, and mental models*	**Study organisation**	**Sector:** *National*	*International*	**Infrastructure generally**
Benefit management	Results in processes for managing benefits.	Results in the practice of system stewardship. Moves out of project-led paradigm.	Processes move beyond outcomes to aptitude and adjust to the dynamic nature of the system.	✓	✓	✓	✓ Specific lessons, broad issues and approach relevant to other sectors (e.g. technology).

	Ability to learn			Ability to influence			
	Single-loop: *Incremental improvement. No questioning of underlying assumptions*	**Double-loop:** *Revisiting the underlying assumptions of a normative framework*	**Triple-loop:** *Review of underlying values, belief-systems, and mental models*	**Study organisation**	**Sector:** *National*	**Sector:** *International*	**Infrastructure generally**
cOPEX	Results in improved cOPEX estimating template for asset management. Improved estimates.	Change in accounting practice for infrastructure. Results in whole of organisation/lifecycle approach. Similarly influences other cross functional processes.	Rewrites approaches based on transformative change and customer-oriented systems.	✓	✓	✓	✓ Specific lessons, broad issues and approach relevant to other sectors (e.g. three waters).

	Ability to learn			Ability to influence			
	Single-loop: *Incremental improvement. No questioning of underlying assumptions*	**Double-loop:** *Revisiting the underlying assumptions of a normative framework*	**Triple-loop:** *Review of underlying values, belief-systems, and mental models*	**Study organisation**	**Sector:**		**Infrastructure generally**
					National	*International*	
Road Smoothness	Influences areas of practice such as avoiding the placement of road works signs in paths and cycle lanes. Selection of performance indicators revisited.	Changes assessment methodology to include paths and road pavement cross-sections (changes assumption of 'customer', assumed boundaries). Similarly influences other indicators.	Fundamental reorientation of technical approaches to customer —based on customer determined (i.e. not assumed) requirements.	✓	✓	✓	✓ Broad lessons and approach relevant to other sectors (e.g. service infrastructure).

The Table shows that this research is applicable at multiple levels and scales, and has the potential to enable 'triple-loop learning' or a change to underlying belief-systems and mental models. This speaks to the nested nature of complex systems (Section 1.2) and that of system aptitude, which is more than the attributes of the system, but also the inherent or acquired ability *and inclination* of the system to respond and adapt to its evolving context (Section 2.3). Moreover, challenging from first principles, whilst arguably necessary for purposefully 'disruptive thinking' (Dobbs et al., 2015), still needs to be socialised, understood, and takes time (Yankelovich in Constanza, 2000; see also Chapter 2). This is particularly so at the levels of organisational-, sector-, and general infrastructure-practice considered here. This research contributes to that 'socialising' process[80] by providing evidence to raise awareness and develop understanding. It has also provided sense-making models and recommendations to contribute to practice improvement.

So, ultimately the applicability of the research will depend on the willingness and the ability of an organisation/sector/industry to respond to the issues and opportunities that have been raised. The 'influencing change' workshops have already started the process and have shown how the change process might be approached.[164] In this regard, Auckland Transport has advised that it is currently (Auckland Transport, pers. comm., 12 September 2016):

> *Reviewing the role of asset management in the organisation* [...] *one strand of which is the involvement of asset management and operations in early design decisions and the consenting process to ensure whole of life costs and customer needs are considered* [...] *We are also actively reviewing how benefits management can influence investment decisions at a systems level and how customer perceptions of road smoothness may influence future investment decisions. It is early days for these two work streams but already there is a clear indication that system level benefits will accrue.*

[164] Sections 7.4.1, AVI.4, AVIII.3.2.

Study 3's influencing change workshop (Appendix VIII) also formally formed part of the change process for the NZTA, and was supported by an executive 'white paper' which considered how the research might interface with other key organisational initiatives.[165]

However, although change is clearly intended (and forthcoming), it is not within the scope of this research to either implement that change or to monitor its effectiveness (Section 4.3). That is a future opportunity. But given the complexity of the system, the point is that the effects of any change should not be completely discernible/separable, and that by effecting any change, the system itself has evolved. In other words, the system is chaordic (Olmedo, 2010). In this regard, the sense-making models generated within each of the detailed studies should assist in supporting change;[166] not only for the study organisations and the New Zealand land transport sector, but more widely within infrastructure practice. Whilst the details within each study or process might differ, these are shared lifecycle interfaces and broadly common issues (Chapter 3).

Those same models are also complementary. This research deduced the need for system stewardship (Chapter 5); whether as a formal role, or as a boundary-spanning culture/mindset within an organisation, sector, or the wider industry. The other sense-making models[166] support the function/notion of system stewardship and should therefore assist sense-making both within and across the system. They should also assist in orienting practice towards adaptive practice and customer-oriented outcomes.

[165] The reports prepared for study 3 have also been provided to the NZTA, and form part of their research library (NZTA, *pers. comm*., 20 April 2015).

[166] System stewardship (study 1; Figure 5.1), modified operating model (study 2; Figure 6.4), and 'outcome differentiation' (study 3; Section 7.4). See also Figure 9.1 and the overarching research methodology as a sense-making and diagnostic tool.

10 REFLECTION AND CONCLUSIONS

This Chapter reflects upon the wider research matters including the academic contribution of this research and the scope for further research. It then draws together the overall research conclusions.

10.1 Reflection

10.1.1 Mental models and the infrastructure lifecycle paradigm

The conventional infrastructure lifecycle (of plan, build, maintain, dispose) presumes the building of more projects and then the optimisation of those hard assets. This may have been appropriate in the establishment of ‘new world’ economies or in response to specific events such as post-world war or disaster recovery. However, this ‘pipeline’ view of infrastructure does not necessarily assist (as best it might), with managing the complexities of less tangible objectives and the messy, non-linear reality of day to day service-led infrastructure management. Edkins and Zerjav (2014) contend the asset-based and service or provision-based typologies need to be broadened, and Snowden and Boone (2007) have already told us that the application of simple solutions or approaches can fail when applied to a complex situation or system.

The concept of a system-centric lifecycle had been developed before commencing this research (see Blom, 2014). The concept separated the delivery of projects from business-as-usual operations, and recognised that these were means through which the system transformed, but not in itself its *raison d’être* (Figure 3.1). This was proposed as a mental model through which this research was investigated, largely to facilitate systems thinking at the system level. Whilst this research did not set out to test or prove the concept described within Figure 3.1, the model not only emerged as novel, but apposite, particularly as it aligns with, and supports, propositions 2 and 3.

It is the project-centric mindset that continues to be problematic. In short, conventional, linear thinking goes only so far in delivering intended long-term infrastructure outcomes. A new ‘philosophy’ is required, one that is both focused on outwardly-looking outcomes, and is systems-oriented. This is a point supported by not only the preliminary research, but also the three detailed studies:

- Study 1 highlighted the current focus upon technical or ‘in house’ outcomes such as those benefits strongly coupled with funding criteria, project management, or departmental (or personal) performance metrics.
- Study 2 showed the limitations of functional support tools (such as those oriented around one part of the asset base) and silos rather than whole-of-organisation, whole-of-life thinking and practice.
- Study 3 demonstrated what can happen when technical outputs are misconstrued as customer outcomes.

This is where this research has demonstrated the system lifecycle model offered by Blom (2014) has a contribution to make:

- The model was critical to the methodological framework developed for this research which now offers another means for approaching complex infrastructure systems. It is as much a way of thinking as a representation of the system lifecycle and notably the:
  - transformative (but not central) role of projects; and
  - eventual assimilation and subsuming of those projects into the ‘system’.
- The model provides an alternative framework for stimulating changes in infrastructure management and supporting disciplines (such as project and asset management). The model as much supporting the reorienting of organisations, processes, and structures, as a change in mindset and culture.
- The paucity of systems-level infrastructure research and the subsequent findings of this research indicate that the model is not only ‘interesting’ (Davis, 1971) in practice (from whence it was developed), but also in theory.

10.1.2 Methodological insights

As Rabah (2015) observes:

> *Issues in public administration are very complex and engage phenomena that are not easily manipulated and identified (Wright, Manigault, and Black, 2004)* [...] *Making a decision of whether to use a qualitative, a quantitative or a mixed method in studying public administration is not based on legitimacy of any of these methods but it depends on how to apply a method that reveals confident research results. There should be a "move beyond arguments as to which research is more legitimate, toward discussions as to whether the methods have been appropriately used" (Lan and Anders, 2000, p. 150).*

Experiences garnered and the results obtained through this research would support Rabah's observation and those current proponents of probing, pluralist, trans-disciplinary research into complex systems discussed earlier. The methodological approach developed and adopted here has enabled the layered and multi-faceted nature of a complex system to be investigated to reveal evidence from the detailed (micro) through to the system (macro) level:

Whole-of-system working road map

Complexity and Systems Thinking literature warns against trying to simplify complexity, but rather to learn how to respond and adapt to it instead (e.g. Gunderson & Holling, 2002; Snowden & Boone, 2007). As such, the methodology has proven useful in its own right; one of the key advantages of the approach is that it provides a form of road map, both about how to approach complex issues, and how diffuse, high-level questions might be addressed systemically. The methodology has enabled both detailed and system level insight, without an expectation that there be a simple, replicable and/or identifiable solution. This is an important for both academics and practitioners alike when faced with an ever changing and evolving array of issues and key areas of interest that means probing/diagnosing the system is not a one-off exercise.

The methodology, then, contributes to our understanding of a 'systems level approach' — of Systems Thinking at the system level — and how that might be put into practice. In the very least, in the area of public infrastructure administration as researched here, this responds to a recognised need (see Jowitt, 2013).

The methodology provided a research mechanism and framework for collating system-level stories and evidence to enable sense-making and shared meaning (discussed below) for without this we cannot be sure of whether the problems are material, and are left with unconnected anecdotes that are of limited value in improving the delivery of infrastructure outcomes.

Sense-making and socialising

Whilst the methodology does provide a road map and gives meaning to a systems-level approach to infrastructure administration, this is more sense-making model (Weick et al., 2005) than 'how to' guide, check list, or 'cook book', as it:

- outlines an example to follow that makes sense of the system without defining its boundaries and limiting its meaning or applicability;
- recognises that the system is dynamic and therefore that the investigation and response is ongoing;
- collates stories for shared understanding and learning and enables stakeholders within those stories, with similar stories, or within the wider system to understand where they fit;
- accommodates the duality of Action Research and the need to not only provide sense and plausible outcomes for practitioners and academics, but different stakeholder groups within these;
- results in plausible outcomes and 'lessons in action' by way of detailed evidence which provides not only insights into the specifics of a given aspect, but enables reflection upon the wider system and future implications (i.e. sense-giving and coming to resolution; see Table 2.1).
- that same evidence can then be triangulated with stories to provide meaning and relevance to others within the wider industry, and 'clues' as to where to probe within their own systems; and

- provides a focus and forum through which challenging outcomes and concepts may be discussed and socialised to assist with culture change, wider uptake, and action.

Many of these relate to the development of understanding (‘consciousness raising’) identified by Yankelovich (1991) and the need to address the “*perceived applicability to self*” and “*concreteness and clarity*” of an issue (Ibid, pp.77-79; see also Table 2.1, this document). Given that this research started from the position of emergent theory, that academic evidence is scant, and ‘the problem’ had not yet crystallised within the collective consciousness of infrastructure practice, these attributes are particularly important. So too is the ability to sense-make and socialise the problem, describe both its characteristics and the wider issues (Davis, 1971; see also Table 2.1, this document), and a willingness and ability (aptitude) to learn and evolve.

Diagnostics

Whilst the academic literature considers the deep dive as an executive intervention (and there are limited examples of this; Yu and Bower (2009) being one), the literature does not appear to contemplate its use as a diagnostic tool. Because the deep dive is more than an audit (as it drives from first principles), the methodology outlined here can fulfil this diagnostic function. It does so by identifying ‘clues’ to where systemic problems may reside, and increasing our shared understanding of these (see Table 2.1).

However, as noted, this is not a one-off diagnostic process. Indeed, Dobbs et al. (2015) argue that such an approach is a necessity in the current age of disruption and complexity:

> *Our intuition has been formed by a set of experiences and ideas about how things worked during a time when changes were incremental and somewhat predictable* [...] *In the new world, executives, policy makers, and individuals all need to scrutinize their intuitions from first principles and boldly reset them if necessary. This is especially true for organizations that have enjoyed great success.*

Any evolution in approaches to organisational structure and practice (e.g. Piercy, 2009) is likely to only serve to further underline the need for ongoing system diagnostics and research into 'whole-of-system working' (see Jackson, 2009a).

Limitations and opportunities

However, there are a number of limitations which do exist with the approach. Those inherent within methodological preference and novelty have been well canvassed by others or resolved already within this thesis (Chapter 4), so not discussed further. Other limitations (and also embedded opportunities) include:

- ***Understanding/communicating component relevance***: This approach requires there to be a shared understanding of the working and nature of the system in question otherwise the relevance of component deep dives may be lost to others. Ultimately this becomes a communication challenge (and therefore a sense-making opportunity), as linking the component parts to the wider 'whole' remains intrinsic to systems research (Edson & Metcalf, 2017).

- ***Ability to see both the wood and the trees***: The approach outlined here provides detail at multiple scales and from several perspectives. This invokes an ability to consider often contradictory positions or paradox. The level of detail (both the detail within the deep dives and/or at the system level) may not be accessible to everyone, may even confuse, and therefore could impede socialising and uptake.

  The flip side of this is, as noted above, stakeholders have multiple opportunities to find meaning/relevance, and/or to understand where they fit (this also references the concepts of single- double-, and triple-loop learning discussed earlier).

- ***Selling success***: Unfortunately the approach, although robust, does not offer a 'silver bullet' or single solution. Therefore defining success, let alone measuring it may be problematic (including issues described by Lester (2004)). The approach requires a move away from the expectation of 'command and control' style single solution outcomes; albeit, such a move is encouraged by Yankelovich (1991), amongst others. Whilst simple, single solutions are problematic in complex systems (Seddon, 2008), there may be reluctance to invest in, or support an approach that is 'impact challenged'. There is also a risk that corrective action which responds to initial diagnostics is mistaken for a need for the system to be continually re-evaluated and reset. Incremental improvement and the standardisation of diagnostic tools may then embed a risk of failure (Snowden & Boone, 2007).

The opportunity here is that a programme of ongoing diagnostics provides practitioners a model to assist evolution and to contribute to adaptive capability. For researchers, ongoing diagnostics provide the opportunity to understand matters such as the longitudinal implications of the approach and to contribute to the ongoing development of the interwoven, trans-disciplinary mesh of Complexity Theory, Systems Thinking, and Public Administration (amongst others).

By understanding the approach as a sense-making model that has the intrinsic aim of stimulating conversation and shared understanding, the limitations of the approach can therefore be recast as opportunities. From both practitioner and academic perspectives, the methodology provides an effective means of testing whether strategic intent has been organised into actions that will have meaning at multiple levels (Section 4.3.3). In this regard, the research is repeatable within different contexts, or with a different focus, enabling other cross-case comparisons to be made on system-level matters. At the same time, the approach enabled the complexities of the New Zealand land transport sector to be probed across multiple processes, organisations, scales, and perspectives to provide insights into where and why the system was underperforming. This responds to Hartley and Skeltcher's challenge (see Section 2.4) that evidence-based theory in the realm of public service improvement is "*better assessed through the achievements of the whole institutional field*" (in Hartley et al., 2008, pp. 10-11).

10.1.3 Academic contribution

This research has investigated the rather diffuse problem of the relationship between the strategic intent and management of infrastructure systems, using the New Zealand land transport sector to probe issues from different perspectives. The research has been able to be generalised by using cross-sectoral and cross-country material obtained from earlier interviews (as similar stories also arise in other contexts), to conclude:

> *The strategic intent and the day-to-day management of infrastructure systems are often misaligned, with negative consequences for achieving the desired long-term infrastructure system outcomes.*

This is supported by three underpinning propositions (Section 2.1).

Section 9.2.2 discusses the practical implications of this. The academic contribution has a number of dimensions, which include those covered within the previous two sections. In addition, this research:

- provides a ‘worked’ example of the application of Systems Thinking to Action Research (Flood, 2010), of which there are few applied whole-of-system working examples and none in built infrastructure sectors (Jackson, 2009a); and
- for this reason contributes to the wider corpus of ‘pracademic’ literature (M. Bolton & Stolcis, 2003), and so seeks to bridge the knowledge gap in a number of areas (which follow).
- extends the issues raised by Almklov and Antonsen (2014; see Section 1.1); so providing further evidence as to why the New Public Management model may be problematic for public sector infrastructure administration. It also provides sense-making models to address some of the issues encountered;
- supports current proponents of trans-disciplinary research into complex systems (e.g. Gunderson & Holling, 2002; Snowden & Boone, 2007);
- contributes to:
  - engineering knowledge within each of the detailed study areas, including challenging some of the orthodoxies of infrastructure practice (e.g. see Moodley, 2015 in response to Blom, De Marco, and Guthrie, 2015);
  - the nexus of public administration/services, New Public Management, general management and business practice, engineering, infrastructure administration, and even disciplinary areas such as Asset Management. However, any contribution to any individual practice cannot be unpicked as they were approached together and the research focused on the blended, trans-disciplinary ‘grey-space’ of practice. Yet it can be said that the research contributes to the development of multi-level, trans-disciplinary

management research, and in particular the implementation of strategy, which Hitt et al. (2007) tell us is still missing from the academic literature.

The research, then, contributes to our understanding of a ‘systems level approach’ — of Systems Thinking at the system level — and how that might be put into practice (responding to Jowitt (2013)). All this makes the research ‘interesting’ (Davis, 1971).

10.1.4 Scope for future research

Irrespective of the outcomes and contribution of this research, there remains considerable scope for further research. This is a diverse opportunity arising from several levels of the research, and includes, but is not limited to:

- additional detailed studies, and/or diversification other infrastructure sectors that add to the understanding of the interface between engineering and management as it relates to infrastructure practice;
- ongoing research to review and reflect upon technical practice: from first principles and to respond to the continually evolving system and its context;
- resolving auxiliary questions, for example:
  - what happens when assets are ‘vested’ to the public by a private developer;
  - whether alternative procurement, such as public/private partnerships necessarily address or defer the issues raised;
- means to improve and tailor finance and human resource practice to better facilitate and respond to the specific needs of public infrastructure administration;
- development of the system-level themes of this research (Chapter 9); and
- the implications of any changes to the system arising from system-level interventions and change arising from the application of Systems Thinking.

It is also the opportunity to develop the ‘conversation’ further, to undertake research that develops each of the ‘Yankelovich’ and ‘Davis’ tranches previously listed in Table 2.1.

10.2 Conclusions

This thesis has investigated the strategic intent and the management of infrastructure systems, how factors such as organisational structure and business practice affect outcomes and the ways in which those *systems* — not projects — are managed. To date, performance has largely been approached from a project-oriented perspective, or through addressing the latent failures arising from specific sources of shock or disruptive events (e.g. natural disaster). By contrast, the delivery of services across the infrastructure system has rarely been examined. Yet this is arguably the level relevant to, and the reality of, day-to-day public infrastructure management.

Infrastructure also exists as an identifiable 'project' for only a relatively short proportion of its lifecycle. Yet operational matters have received relatively little attention and are often overlooked due to a belief that reality reflects theory, and/or that any deviation from theory or 'best practice' is simply a matter of poor individual or organisational performance. The crux of the problem is an inability to fully deliver appropriate and relevant infrastructure outcomes over the long term.

The research firstly investigated industry perception and perspectives to test and define the problem. Three detailed studies then explored the *reasons* for this problem through different lenses, thereby providing an evidence-base for a range of issues shared by the wider infrastructure industry. Accordingly, the results:

- provide a range of novel insights that are applicable to industry at several levels;
- highlight a range of complex, interrelated features of the management of infrastructure systems, which do not fulfil, or align with strategic intent; and
- point to a range of implications for long-term outcomes.

The research has confirmed its hypothesis that:

> *The strategic intent and the day-to-day management of infrastructure systems are often misaligned, with negative consequences for achieving the desired long-term infrastructure system outcomes.*

In so doing this research has increased our understanding of the ways in which that misalignment occurs, and the consequences that result. It found those consequences were material, and frequently not visible within the sub-system accountable for the delivery of those outcomes.

The benefits of public infrastructure to society is a central theme drawn from the definition of infrastructure itself. This research shows that it is not enough to be focused on technical outcomes. Infrastructure needs to move beyond how society interacts with an asset, to the outcomes that reflect the needs, beliefs, and choices of society as well as its ability to respond to change (aptitude). In short, so that society no longer has to work around its infrastructure. In addition, the research has shown:

1. Individual infrastructure projects automatically, by their nature, become part of, are embedded in, *and change*, a complex infrastructural system (e.g. interactions, feedback, emergent properties).

2. The governance and management of such systems will not be effective if focused on outputs at the level of projects, assets, or even subsystems. Governance and management needs to address the desired/intended strategic, externally-oriented outcomes and *aptitude* of the whole system. They also need to address the contributions of individual projects *and* of the day-to-day operations to that system.

3. No matter how well individual projects are designed and delivered, or strategic outcomes are initially defined, systems are dynamic. Accordingly, infrastructure administration needs to both accommodate and continually respond to this time dimension.

The research does not purport to offer '*the* solution'; that does not exist for a complex adaptive system such as infrastructure. But the research *does* offer several system-oriented sense-making models at both the detailed and system-level. This includes the probing methodology by way of a diagnostic roadmap or model. These models aim to assist practitioners in managing the transition of projects, assets, and services into a wider infrastructure system, their potential, and in (re)orienting the organisation to the dynamic nature of the system and its societal imperative.

Whilst the research contributes to both practical and theoretical knowledge, there is still considerable scope for further research. This includes use of the methodological approach, matters of detail arising from the individual detailed studies (e.g. in relation to the vesting of assets; detailed studies 2 and 3), and the development of system-level themes.

Public infrastructure exists, not in its own right, but to benefit society. It also endures and changes in a way that is akin to the metaphorical grandfather's axe. As the metaphor goes, the axe has an inherent value as an heirloom (even if the axe-head and handle are replaced over time). For infrastructure, this equates to the notion of 'future value'. However, in order for our infrastructure to be valued in the future, we perhaps need to start thinking of it as 'our grand*children's* axe'.

UNLESS…

Dr. Seuss

REFERENCES

For brevity, this does not include a full list of the project- and organisation-specific documentation overviewed.

Accident Compensation Corporation. (2015). *Number of new claims due to falls in the road or street (not involving motor vehicles) 2010-2014*.

Ackoff, R. (1971). Towards a system of systems concepts. *Management science, 17*(11), 661-671.

Ackoff, R. (1979). The future of operational research is past. *Journal of the operational research society, 30*(2), 93-104.

Ackoff, R. (1994). Systems thinking and thinking systems. *System Dynamics Review, 10*(2-3), 175-188.

Ackoff, R. (2006). Why few organizations adopt systems thinking. *Systems Research and Behavioural Science, 23*(5), 705-708.

Aikman, I., & Doherty, D. (2006). Overview of infrastructure asset management a view from both sides of the Atlantic Ocean. *Proceedings of the Water Environment Federation, 2006*(8), 4151-4171.

Aldrich, H., & Herker, D. (1977). Boundary spanning roles and organization structure. *Academy of management review, 2*(2), 217-230.

Allee, V., & Schwabe, O. (2009). *Measuring the impact of research networks in the EU: Value networks and intellectual capital formation*. Paper presented at the European Conference on Intelletual Capital, Haarlem, The Netherlands.

Almklov, P., & Antonsen, S. (2014). Making work invisible: New public management and operational work in critical infrastructure sectors. *Public Administration, 92*(2), 477-492.

Alvarez-Rosete, A., Hawkins, B., & Parkhurst, J. (2013). Health system stewardship and evidence informed health policy. *London: GRIP-Health Programme, London School of Hygiene and Tropical Medicine*.

Anguillid Consulting Engineers and Scientists Ltd. (2008). Constellation bus station: Planning overview.

Anguillid Consulting Engineers and Scientists Ltd. (2010). Albany Lakes precinct: Integrated operations management plan.

Anguillid Consulting Engineers and Scientists Ltd. (2012). Public transport and parking facilities: Integrated operational management plan.

Anguillid Consulting Engineers and Scientists Ltd. (2014). Customer perceptions of road infrastructure surface conditions: Report 2 workshop proceedings.

Appelbaum, S. H., & Steed, A. J. (2005). The critical success factors in the client-consulting relationship. *Journal of management development, 24*(1), 68-93.

ARC. (2003). TP10: Stormwater management devices design guidelines manual.

Armitt, J. (2013). The Armitt review: An independent review of long term infrastructure planning commissioned for Labour’s Policy Review.

Arts, J., Caldwell, P., & Morrison-Saunders, A. (2001). Environmental impact assessment follow-up: Good practice and future directions—findings from a workshop at the IAIA 2000 conference. *Impact Assessment and Project Appraisal, 19*(3), 175-185.

Asquith, A. (2016). Public sector management in New Zealand’s local government. In J. Drage & C. Cheyne, (Eds.) (Eds.), *Local government in New Zealand challenges and choices*. Auckland: Dunmore Publishing.

Astorino-Courtois, A., Cabayan, H., Casebeer, B., Chapman, A., DiEuliis, D., Ehlschlaeger, C., . . . Rice, C., (Eds.),. (2012). *National security challenges: Insights from social, neurobiological, and complexity sciences*.

Atkinson, S., & Moffat, J. (2005). The agile organization: From informal networks to complex effects and agility. *Information age transformation series*. Washington, D.C.: CCRP Publications.

Auckland City Council. (2007). Walking action plan 2007-2012: Making walking a more attractive choice.

Auckland Council. (2012a). The Auckland plan.

Auckland Council. (2012b). Funding and market update: Presentation to economic forum.

Auckland Council. (n.d.). Integrated conditions of all consents/permits [AMETI].

Auckland Transport. (2011). Quarry Link Road concept plan and report (body of report updated 2012 ed.).

Auckland Transport. (2012a). 2012/2015 regional land transport programme.

Auckland Transport. (2012b). Statement of intent 1 July 2012-30 June 2015.

Auckland Transport. (2013a). 2012-2041 integrated transport programme.

Auckland Transport. (2013b). Business case for construction: AMETI package 1 Panmure phase 1: To proceed from design to construction.

Auckland Transport. (2014a). Benefits realisation plan: AMETI.

Auckland Transport. (2014b). *Consquential OPEX white paper*.

Auckland Transport. (2014c). Programme initiation document (PID): Auckland Manukau Eastern Transport Initiative (AMETI).

Auckland Transport. (2014d). Statement of intent 2014-2017.

Auckland Transport. (2014e). Statement of intent 2015/16-2018/19.

Auckland Transport. (2015a). AMETI stages map overview.

Auckland Transport. (2015b). Asset management plan 2015-2018.

Auckland Transport. (2015c). Auckland regional land transport plan 2015-2025.

Auckland Transport. (2015d). Close-out and handover of AMETI package 1.

Auckland Transport. (2015e). Parking strategy.

Auckland Transport. (2015f). Regional public transport plan.

Audit New Zealand. (2010). Asset management for public entities: Learning from local government examples.

AustRoads. (2011). User satisfaction index. Retrieved from http://algin.net/austroads/site/index.asp?id=93

Bartunek, J. (2008). You're an organization development practitioner-scholar: Can you contribute to organizational theory? *Organization Management Journal, 5*(1), 6-16.

Basole, R., & Rouse, W. (2008). Complexity of service value networks: Conceptualization and empirical investigation. *IBM systems journal, 47*(1), 53-70.

Bazerman, M. (1994). *Judgment in managerial decision making* (3rd ed.): John Wiley & Sons Inc.

Bergh, D., & Lim, E. (2008). Learning how to restructure: Absorptive capacity and improvisational views of restructuring actions and performance. *Strategic management journal, 29*(6), 593-616.

Bernoulli, D. (1738/1954). Specimen theoriae novae de mensura sortis. [Exposition of a New Theory on the Measurement of Risk]. *Econometrica, 22*(1), 23 - 36.

Bertolini, L., & Salet, W. (2008). Coping with complexity and uncertainty in mega projects: Linking strategic choices and operational decision making. *OMEGA Center Working paper*.

Bessant, J., & Stamm, B. v. (2007). Twelve search strategies that could save your organisation.

Black, D. (1969). Lewis Carroll and the theory of games. *The American Economic Review*, 206-210.

Blom, C. (1997). *A 'DEVICES' approach to environmental management*. Paper presented at the New Zealand Water and Wastes Association Conference, Rotorua, New Zealand.

Blom, C. (2000). *Overview of the New Zealand experience in environmental management for road infrastructure*. Paper presented at the Australian Road Research Board Industry Seminar and Workshop, Sydney.

Blom, C. (2014). *A journey to KAOS: Tackling "wicked" infrastructure. In: The sustainable city IX: Urban regeneration and sustainability*. Paper presented at the 20th International Conference on Urban Transport and the Environment, Portugal.

Blom, C., De Marco, L., & Guthrie, P. (2015). Customer perceptions of road infrastructure surface conditions. *Infrastructure Asset Management, 2*(1), 23–38.

Blom, C., & Guthrie, P. (2015). Surveying customer perceptions of road infrastructure comfort. *Infrastructure Asset Management, 2*(1), 173-185.

Blom, C., & Guthrie, P. (2016). Moving infrastructure benefits beyond projects and programmes. *Proceedings of the Institution of Civil Engineers-Civil Engineering, 169*(2), 56-56.

Blom, C., & Guthrie, P. (2017a). Approaching complexity: Gaining systemic insight through melding methods and boundary spanning. *Journal of Infrastructure Systems [Submitted]*.

Blom, C., & Guthrie, P. (2017b). An argument for infrastructure system stewardship: A New Zealand transportation case study in benefit management. *International Journal of Transport Development and Integration, 1*(4), 611–623.

Blom, C., & Guthrie, P. (2017c). Infrastructure outcomes: What new project operational expenditure reveals as missing. *Proceedings of the Institution of Civil Engineers-Municipal Engineer, [Online ahead of print]*.

Blom, C., & Guthrie, P. (2017d). Strategic intent and the management of infrastructure systems. *Proceedings of the Institution of Civil Engineers–Engineering Sustainability [Accepted for peer review]*.

Blom, C., & Guthrie, P. (2017e). Towards long-term infrastructure performance *Proceedings of the Institution of Civil Engineers–Engineering Sustainability, 170*(3), 157-168.

Blom, C., & Irwin, A. (2011). *Piloting a new approach to asset management: The stormwater story.* Paper presented at the Water New Zealand 7th South Pacific Stormwater Conference, Auckland, New Zealand.

Blom, C., Irwin, A., & Rangamuwa, S. (2011). *A new model for asset management: Albany Lakes Precinct*. Paper presented at the European Transport Conference, Glasgow.

Boal, K., & Schultz, P. (2007). Storytelling, time, and evolution: The role of strategic leadership in complex adaptive systems. *The Leadership Quarterly, 18*(4), 411-428.

Bollinger, L., & Dijkema, G. (2012). Resilience and adaptability of infrastructures–A complex adaptive systems perspective.

Bolton, M., Bass, E., & Siminiceanu, R. (2008). *Using formal methods to predict human error and system failures.* Paper presented at the Proc. 2nd Int. Conf. appl. human factors ergonom.

Bolton, M., & Stolcis, G. (2003). Ties that do not bind: Musings on the specious relevance of academic research. *Public Administration Review, 63*(5), 626-630.

Bonsall, P., Beale, J., Paulley, N., & Pedler, A. (2005). The differing perspectives of road users and service providers. *Transport Policy, 12*(4), 334-344.

Bosch, O., Nguyen, N., Maeno, T., & Yasui, T. (2013). Managing complex issues through evolutionary learning laboratories. *Systems Research and Behavioural Science, 30*(2), 116-135.

Boulus-Rødje, N. (2014). Managing normative criteria in action research. *Scandinavian Journal of Information Systems, 26*(2), 79-102.

Bourne, L., & Walker, D. (2005). Visualising and mapping stakeholder influence. *Management decision, 43*(5), 649-660.

Box, R. (1999). Running government like a business: Implications for public administration theory and practice. *The American Review of Public Administration, 29*(1), 19-43.

Breese, R. (2012). Benefits realisation management: Panacea or false dawn? *International Journal of Project Management, 30*(3), 341-351.

Brown, D., Liu, W., & Henning, T. (2010). Identifying pavement deterioration by enhancing the definition of road roughness.

Brown, M., Clarkson, B., Barton, B., & Joshi, C. (2013). Ecological compensation: An evaluation of regulatory compliance in New Zealand. *Journal of Impact Assessment and Project Appraisal, 31*(1), 1-11.

Brugnach, M., Dewulf, A., Pahl-Wostl, C., & Taillieu, T. (2008). Toward a relational concept of uncertainty: About knowing too little, knowing too differently, and accepting not to know. *Ecology & Society, 13*(2).

Bryman, A. (2001). Social research methods. Oxford, UK: Oxford University Press.

Bryman, A., & Bell, E. (2011). *Business research methods* (3rd ed.). Oxford: Oxford University Press.

Busby, J. (1998). The neglect of feedback in engineering design organisations. *Design Studies, 19*(1), 103-117.

Busby, J. (2001). Error and distributed cognition in design. *Design Studies, 22*(3), 233-254.

Campbell, J., Jardine, A., & McGlynn, J., (Eds.). (2011). *Asset management excellence: Optimizing equipment life-cycle decisions* (2nd ed.). Boca Raton: CRC Press.

Carew, A., & Wickson, F. (2010). The TD wheel: A heuristic to shape, support and evaluate transdisciplinary research. *Futures, 42*(10), 1146-1155.

Carreras, C., & De Soto, P. (2013). The Roman transport network: A precedent for the integration of the European mobility. *Historical Methods: A Journal of Quantitative and Interdisciplinary History, 46*(3), 117-133.

Carroll, L. (1954). *Alice's adventures in wonderland and through the looking-glass*. London: J M Dent & Sons Ltd.

Coghlan, D. (2011). Action research: Exploring perspectives on a philosophy of practical knowing. *The Academy of Management Annals, 5*(1), 53-87.

Constanza, R. (2000). Visions of alternative (unpredictable) futures and their use in policy analysis. *Conservation ecology, 4*(1), 5.

Controller and Auditor-General. (2002). Managing the relationship between a local authority's elected members and its chief executive.

Controller and Auditor-General. (2010). New Zealand Transport Agency: Information and planning for maintaining and renewing the state highway network.

Controller and Auditor-General. (2014a). Local government: Results of the 2012/13 audits.

Controller and Auditor-General. (2014b). Water and roads: Funding and management challenges. New Zealand: Office of the Auditor-General.

Controller and Auditor-General. (2015). Reviewing aspects of the Auckland Manukau Eastern Transport Initiative. New Zealand: Office of the Auditor-General.

Courtney, H., Kirkland, J., & Viguerie, P. (1997). Strategy under uncertainty. *harvard business review, 75*(6), 67-79.

Crabbé, P., & Robin, M. (2006). Institutional adaptation of water resource infrastructures to climate change in Eastern Ontario. *Climatic Change, 78*(1), 103-133.

Cromwell, B. (1991). Public sector maintenance: The case of local mass-transit. *National Tax Journal, 44*(2), 199-212.

Daily, C., Dalton, D., & Cannella, A. (2003). Corporate governance: Decades of dialogue and data. *Academy of management review, 28*(3), 371-382.

Damart, S., & Roy, B. (2009). The uses of cost–benefit analysis in public transportation decision-making in France. *Transport Policy, 16*(4), 200-212.

Davis, M. (1971). That's interesting: Towards a phenomenology of sociology and a sociology of phenomenology. *Philosophy of the social sciences, 1*(4), 309.

De Geus, A. (2002). *The living company*: Harvard Business Press.

de Wit, B., & Meyer, R. (2010). *Strategy: Process, content, context : An international perspective* (4th ed.). UK: South-Western Cengage Learning.

Deloitte. (2013). Auckland Transport: Growing public transport patronage by 2022.

Denhardt, R., Denhardt, J., & Blanc, T. (2013). *Public administration: An action orientation*: Cengage Learning.

Denscombe, M. (2011). *The good research guide: For small-scale social research projects* (4th ed.). Berkshire: Open University Press.

Department for Transport (UK). (2012). Prevention and a better cure: Potholes review.

Department of Internal Affairs. (2011). Local government sector profile. Retrieved from http://www.localcouncils.govt.nz/

Department of Internal Affairs. (2013). *Local government non-financial performance measures*.

Desouza, K., & Flanery, T. (2013). Designing, planning, and managing resilient cities: A conceptual framework. *Cities, 35*(0), 89-99.

Dias, W., Subrahmanian, E., & Monarch, I. (2003). Dimensions of order in engineering design organizations. *Design Studies, 24*(4), 357-373.

Dickens, L., & Watkins, K. (1999). Action research: Rethinking Lewin. *Management Learning, 30*(2), 127-140.

Dobbs, R., Manyika, J., & Woetzel, J. (2015). The four global forces breaking all the trends. No Ordinary Disruption: McKinsey Global Institute. Retrieved from http://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/the-four-global-forces-breaking-all-the-trends.

Dobbs, R., Pohl, H., Lin, D.-Y., Mischke, J., Garemo, N., Hexter, J., . . . Nanavatty, R. (2013). Infrastructure productivity: How to save $1 trillion a year: McKinsey Global Institute.

Doz, Y., & Kosonen, M. (2014). Governments for the future: Building the strategic and agile state.

Dunleavy, P., & Hood, C. (1994). From old public administration to new public management. *Public money & management, 14*(3), 9-16.

Durango-Cohen, P. (2007). A time series analysis framework for transportation infrastructure management. *Transportation Research Part B: Methodological, 41*(5), 493-505.

Easton, G. (1992). *Learning from case studies* (2nd ed.). New York; London: Prentice Hall.

Eboli, L., & Mazzulla, G. (2009). A new customer satisfaction index for evaluating transit service quality. *Journal of Public Transportation, 12*(3), 21-37.

Edkins, A., & Zerjav, V. (2014). *A policy program on infrastructure interdependencies: Implications for front-end project management and opportunities for research*. Paper presented at the Working Paper Proceedings Engineering Project Organization Conference, 29th-31st July 2014, Colorado. .

Edson, M., & Metcalf, G. (2017). Evaluating the Impact of Systems Research *A Guide to Systems Research* (pp. 199-234): Springer.

Eisenhardt, K. (1989). Building theories from case study research. *The Academy of Management Review, 14*(4), 532-550.

Engineers Australia. (2012). Australian engineering competency standards stage 2-experienced professional engineer: Engineers Australia.

Eraly, A. (2002). *Gem in the lotus*. London: Penguin Books.

Estache, A., & Fay, M. (2010). Current debates on infrastructure policy. *Globalization and Growth Implications for a Post-Crisis World*, 151-193.

Fairclough, R. (2012). *National infrastructure plan-resilience*.

Fairclough, R. (2014). Infrastructure resilience: National Infrastructure Unit, New Zealand Treasury.

Farquhar, J. D. (2012). *Case study research for business*: Sage.

Federal Highways Administration. (2005). Transportation asset management in Australia, Canada, England, and New Zealand. Washington DC: Office of International Programs.

Fenner, R., & Ainger, C. (2014). *Sustainable infrastructure: Principles into practice*. UK: ICE Publications.

Feyerabend, P. (2010). *Against method* (4th ed.). London: Verso.

Fiss, P. (2009). Case studies and the configurational analysis of organizational phenomena. *Handbook of case study methods*, 424-440.

Flick, U. (2002). *An introduction to qualitative research* (2nd ed.). London: Sage Publications.

Flood, R. (2010). The relationship of 'systems thinking' to action research. *Systemic Practice and Action Research, 23*(4), 269-284.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative inquiry, 12*(2), 219-245.

Flyvbjerg, B. (2009). Survival of the unfittest: Why the worst infrastructure gets built—and what we can do about it. *Oxford Review of Economic Policy, 25*(3), 344-367.

Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and risk: An anatomy of ambition*: Cambridge University Press.

Flyvbjerg, B., Holm, M., & Buhl, S. (2002). Underestimating costs in public works projects: Error or lie? *Journal of the American Planning Association, 68*(3), 279-295.

Flyvbjerg, B., Skamris Holm, M., & Buhl, S. (2003). How common and how large are cost overruns in transport infrastructure projects? *Transport Reviews, 23*(1), 71-88.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C., & Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. *AMBIO: A journal of the human environment, 31*(5), 437-440.

Ford, J. D., & Schellenberg, D. A. (1982). Conceptual Issues of Linkage in the Assessment of Organizational Performance1. *Academy of management review, 7*(1), 49-58.

Forrester, J. (1964). Common foundations underlying engineering and management. *Spectrum, IEEE, 1*(9), 66-77.

Franco-Santos, M., Kennerley, M., Micheli, P., Martinez, V., Mason, S., Marr, B., . . . Neely, A. (2007). Towards a definition of a business performance measurement system. *International Journal of Operations & Production Management, 27*(8), 784-801.

Freeman, R. (2010). *Strategic management: A stakeholder approach*: Cambridge University Press.

Freeman, R., & McVea, J. (2001). A stakeholder approach to strategic management.

Gaziulusoy, A. (2010). *System innovation for sustainability: A scenario method and a workshop process for product development teams.* (PhD), Auckland University.

Geels, F. W. (2007). Transformations of large technical systems: A multilevel analysis of the Dutch highway system (1950-2000). *Science, Technology & Human Values, 32*(2), 123-149.

Geiger, D., Wells, P., Bugas-Schramm, P., Love, L., McNeil, S., Merida, D., . . . Velasquez, L. (2005). Transportation asset management in Australia, Canada, England, and New Zealand. *International Technology Exchange Program*.

Geurs, K., & van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: Review and research directions. *Journal of Transport Geography, 12*(2), 127-140.

GHD. (2007). Rates inquiry: Report on the drivers of local government expenditure.

GHD. (2015). Infrastructure maintenance: A report for Infrastructure Australia.

Ghobadian, A., O'Regan, N., Howard, T., Gallear, D., Kathuria, R., Joshi, M. P., & Porth, S. J. (2007). Organizational alignment and performance: Past, present and future. *Management decision, 45*(3), 503-517.

Goodman, P., & Ramanujam, R. (2012). The relationship between change across multiple organizational domains and the incidence of latent errors. *The Journal of Applied Behavioral Science, 48*(3), 410-433.

Government of Karnataka. (2004). Second road user satisfaction survey in Karnataka: Main study report (final).

Grant, G., McKnight, S., Uruthirapathy, A., & Brown, A. (2007). Designing governance for shared services organizations in the public service. *Government Information Quarterly, 24*(3), 522-538.

Grant, R., Butler, B., Hung, H., & Orr, S. (2011). *Contemporary strategic management: An Australasian perspective*. Milton, Australia: John Wiley & Sons Australia Ltd.

Green, S. (1994). Beyond value engineering: SMART value management for building projects. *International Journal of Project Management, 12*(1), 49-56.

Greffioz, J., Olver, A., & Schirmer, P. (1993). *TOPEX: an expert system for estimating and analyzing the operating costs of oil and gas production facilities.* Paper presented at the SPE Asia Pacific Oil and Gas Conference.

Gunderson, L., & Holling, C. (2002). *Panarchy: Understanding transformations in human and natural systems*. Washington, D. C.: Island Press.

Guthrie, P., & Konaris, T. (2012). State of the world report 2012: Sustainable infrastructure: International Federation of Consulting Engineers (FIDIC).

Haas, R., Felio, G., Lounis, Z., & Cowe Falls, L. (2009). *Measurable performance indicators for roads: Canadian and international practice.* Paper presented at the Annual Conference of the Transportation Association of Canada, Vancouver.

Hacking, T., & Guthrie, P. (2008). A framework for clarifying the meaning of triple bottom-line, integrated, and sustainability assessment. *Environmental Impact Assessment Review, 28*(2–3), 73-89.

Hall, J., Henriques, J., Hickford, A., & Nicholls, R. (2013). Systems-of-systems analysis of national infrastructure. *Proceedings of the ICE-Engineering Sustainability, 166*(5), 249-257.

Hallsworth, M. (2012). How complexity economics can improve government: Rethinking policy actors, institutions and structures. *Complex new world: translating new economic thinking into public policy, London: IPPR (Institute for Public Policy Research)*, 39-49.

Hamel, G., & Prahalad, C. K. (2013). *Competing for the future*: Harvard Business Press.

Harford, T. (2011). *Adapt: Why success always starts with failure*. Great Britain: Abacus.

Harris, G. (2007). *Seeking sustainability in an age of complexity*: Cambridge University Press.

Hartley, J. (2004). Case study research. *Essential guide to qualitative methods in organizational research*, 323-333.

Hartley, J., Donaldson, C., Skelcher, C., & Wallace, M., (Eds.). (2008). *Managing to improve public services*: Cambridge University Press Cambridge.

Heath, H., & Cowley, S. (2004). Developing a grounded theory approach: A comparison of Glaser and Strauss. *International journal of nursing studies, 41*(2), 141-150.

Hellström, T. (2007). Critical infrastructure and systemic vulnerability: Towards a planning framework. *Safety Science, 45*(3), 415-430.

Hendriks, F., & Tops, P. (1999). Between democracy and efficiency: Trends in local government reform in the Netherlands and Germany. *Public Administration, 77*(1), 133-153.

Hendriks, F., & Tops, P. (2003). Local public management reforms in the Netherlands: Fads, fashions and winds of change. *Public Administration, 81*(2), 301-323.

Henning, T., Costello, S., & Tapper, M. (2013). Performance indicator analysis and applying levels of service.

Higgins, E. (2000). Making a good decision: Value from fit. *American psychologist, 55*(11), 1217-1230.

Hillier, B. (2007). Space is the machine: A configurational theory of architecture.

Hitt, M. A., Beamish, P. W., Jackson, S. E., & Mathieu, J. E. (2007). Building theoretical and empirical bridges across levels: Multilevel research in management. *Academy of Management Journal, 50*(6), 1385-1399.

HM Treasury. (2011). The green book: Appraisal and evaluation in central government *Treasury Guidance*. London.

Hobday, M. (2000). The project-based organisation: An ideal form for managing complex products and systems? *Research Policy, 29*(7–8), 871-893.

Holling, C. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics, 4*, 1-23.

Holling, C. (2001). Understanding the complexity of economic, ecological, and social systems. *Ecosystems, 4*(5), 390-405.

Holmgren, M. (2005). Maintenance-related losses at the Swedish Rail. *Journal of Quality in Maintenance Engineering, 11*(1), 5-18.

Hood, C. (1991). A public management for all seasons? *Public Administration, 69*(1), 3-19.

Hood, C., & Peters, G. (2004). The middle aging of new public management: Into the age of paradox? *Journal of public administration research and theory, 14*(3), 267-282.

Horwath, R. (2009). *Deep dive: The proven method for building strategy, focusing your resources, and taking smart action*. Kindle version: Greenleaf Book Group.

Howlett, P., & Morgan, M., (Eds.). (2011). *How well do facts travel? The dissemination of reliable knowledge*. Cambridge: Cambridge University Press.

Huang, H. B. (2010). What is good action research. *Action Research, 8*(1), 93-109.

Hudson, B. (2006). Whole systems working: A guide and discussion paper.

Hussein, B. A., & Hafseld, K. H. (2016). Organisational influences impacting user involvement in a major information system project: A case study in a governmental organisation. *International Journal of Project Organisation and Management, 8*(1), 24-43.

IPENZ. (2010). Assessing the state of infrastructure: Is what you see what you get? Wellington.

ISO. (2011). ISO 15686-1:2011 Buildings and constructed assets. Service life planning--Part 1: General principles and framework.

ISO. (2014a). BS ISO 55000 series-asset management BS ISO55000:2014, BS ISO 5501:2014 and BS ISO 55002:2014.

ISO. (2014b). BS ISO 55000:2014 Incorporating corrigendum March 2014-asset management overview, principles and terminology.

Iwarsson, S., & Ståhl, A. (2003). Accessibility, usability and universal design-positioning and definition of concepts describing person-environment relationships. *Disability & Rehabilitation, 25*(2), 57-66.

Jackson, M. (2009a). Fifty years of systems thinking for management. *Journal of the operational research society*, S24-S32.

Jackson, M. (2009b). Managing the tensions created by mixing methods: Comments for Eden et al from a critical systems perspective. *The Journal of the Operational Research Society, 60*(9), 1297-1299.

Joerges, B., & für Sozialforschung, W. B. (1998). *High variability discourse in the history and sociology of large technical systems*: Citeseer.

Johnson, G. (n.d.). Impact of non-freeway rumble strips.

Johnson, P., & Duberley, J. (2000). Understanding management research [electronic resource]: An introduction to epistemology. London: SAGE Publications.

Johnston, R., & Pongatichat, P. (2008). Managing the tension between performance measurement and strategy: Coping strategies. *International Journal of Operations & Production Management, 28*(10), 941-967.

Jowitt, P. (2010). Now is the time. *Proceedings of ICE–Civil Engineering, 163*(1), 3.

Jowitt, P. (2013). Decisions, decisions. *Civil Engineering and Environmental Systems, 30*(3-4), 285-293.

Jowitt, P., & Milke, M. (2013). Editorial. *Civil Engineering and Environmental Systems, 30*(3-4), 173-174.

Kaplan, R., & Norton, D. (1996). Using the balanced scorecard as a strategic management system. *harvard business review, 74*(1), 75-85.

Kaplan, R., & Norton, D. (2001). The strategy-focused organization. *Strategy and Leadership, 29*(3), 41-42.

Kaplan, R., & Norton, D. (2004). *Strategy maps: Converting intangible assets into tangible outcomes*: Harvard Business Press.

Kaplan, R., & Norton, D. (2008). *The execution premium: Linking strategy to operations for competitive advantage*: Harvard Business Press.

Kauffman, S. (1993). *The origins of order: Self-organization and selection in evolution*: Oxford university press.

Kauffman, S., & Johnsen, S. (1991). Coevolution to the edge of chaos: Coupled fitness landscapes, poised states, and coevolutionary avalanches. *Journal of theoretical Biology, 149*(4), 467-505.

Keenan, T. M. (2016). *The use of aesthetic knowledge in decision making processes in mega projects.* (PhD), Queensland University of Technology, Brisbane.

Kennerley, M., & Neely, A. (2002). A framework of the factors affecting the evolution of performance measurement systems. *International Journal of Operations & Production Management, 22*(11), 1222-1245.

Kennerley, M., & Neely, A. (2003). Measuring performance in a changing business environment. *International Journal of Operations & Production Management, 23*(2), 213-229.

Kessel, F., & Rosenfield, P. L. (2008). Toward transdisciplinary research: Historical and contemporary perspectives. *American Journal of Preventive Medicine, 35*(2), S225-S234.

Key Research. (2013). Gisborne District Council: Community satisfaction survey 2013- final report.

Kim, W., & Mauborgne, R. (2005). *Blue ocean strategy: How to create uncontested market space and make competition irrelevant*: Harvard Business Press.

Knight, A., & Ruddock, L. (2008). *Advanced research methods in the built environment*: John Wiley & Sons.

Koptie, S. (2009). Irihapeti Ramsden: The public narrative on cultural safety. *First Peoples Child & Family Review, 4*(2), 30-43.

Kropáč, O., & Múčka, P. (2005). Be careful when using the International Roughness Index as an indicator of road unevenness. *Journal of sound and vibration, 287*(4), 989-1003.

Land Transport Management Act, 2003 No 118 Stat. (2003).

Lantz, E. (2013). *Operations expenditures: Historical trends and continuing challenges.* Paper presented at the AWEA Wind Power Conference.

Larsen-Freeman, D. (2013). Complexity theory: A new way to think. *Revista Brasileira de Linguística Aplicada, 13*(2), 369-373.

Layard, R., & Glaister, S., (Eds.). (2003). *Cost-benefit analysis* (2nd ed.). Cambridge: Cambridge University press.

Lenferink, S., Tillema, T., & Arts, J. (2008). *The potential of a life-cycle approach for improving road infrastructure planning in the Netherlands.* Paper presented at the Bijdrage aan het colloquium vervoersplanologisch speurwerk, Santpoort.

Lenfle, S., & Loch, C. (2015). Has megaproject management lost its way? Lessons from history.

Lenngren, C., & Granlund, J. (2002). *Relating road roughness to human discomfort and health impact.* Paper presented at the Ninth International Conference on Asphalt Pavements.

Leonard-Barton, D. (1990). A dual methodology for case studies: Synergistic use of a longitudinal single site with replicated multiple sites. *Organization Science, 1*(3), 248-266.

Lester, S. (2004). Conceptualizing the practitioner doctorate. *Studies in Higher Education, 29*(6), 757-770.

Liyanage, J. P., & Kumar, U. (2003). Towards a value-based view on operations and maintenance performance management. *Journal of Quality in Maintenance Engineering, 9*(4), 333-350.

Loasby, B. (1976). *Choice, complexity and ignorance: An enquiry into economic theory and the practice of decision-making*. Cambridge: Cambridge University Press.

Local Government (Auckland Council) Act, (2009).

Local Government Act, (2002).

Local Government New Zealand. (2015). We are. New Zealand.

Loch, C. H., & Tapper, U. (2002). Implementing a strategy-driven performance measurement system for an applied research group. *Journal of Product Innovation Management, 19*(3), 185-198.

Love, P., Lopez, R., Edwards, D., & Goh, Y. (2012). Error begat error: Design error analysis and prevention in social infrastructure projects. *Accident Analysis & Prevention, 48*, 100-110.

Lowndes, V. (1997). Change in public service management: New institutions and new managerial regimes. *Local Government Studies, 23*(2), 42-66.

Lozano, R., Nummert, B., & Ceulemans, K. (2016). Elucidating the relationship between sustainability reporting and organisational change management for sustainability. *Journal of Cleaner Production, 125*, 168-188.

Lupton, T. (1969). *Management and the social sciences: An essay* London Lyon Grant and Green.

Madhavan, R., & Mahoney, J. (2011). Evidence-based management in "macro" areas: The case of strategic management. *Working papers from the University of Illinois at Urbana-Champaign, College of Business*.

Magness, V. (2008). Who are the stakeholders now? An empirical examination of the Mitchell, Agle, and Wood theory of stakeholder salience. *Journal of Business Ethics, 83*(2), 177-192.

Majdzadeh, R., Yazdizadeh, B., Nedjat, S., Gholami, J., & Ahghari, S. (2012). Strengthening evidence-based decision-making: Is it possible without improving health system stewardship? *Health policy and planning, 27*(6), 499-504.

Maori dictionary. (2003-2016). Retrieved from http://maoridictionary.co.nz/

March, J. (1991). How decisions happen in organizations. *Human-Computer Interaction, 6*(2), 95-117.

Maunsell/AECOM. (2007). Albany Civic Crescent scheme assessment report.

May, D., Sapountzis, S., Yates, K., Kagioglou, M., & Aouad, G. (2009). Realising benefits in primary healthcare infrastructures. *Facilities, 27*(3/4).

Mayntz, R., & Hughes, T. P. (1988). *The development of large technical systems*: Campus Verlag.

McArthur, M. (2012). *The meaning and practice of stewardship.* University of Calgary.

McLellan, E., MacQueen, K., & Neidig, J. (2003). Beyond the qualitative interview: Data preparation and transcription. *Field methods, 15*(1), 63-84.

Meredith, J. (1998). Building operations management theory through case and field research. *Journal of Operations Management, 16*(4), 441-454.

Metcalfe, L. (1993). Public management: From imitation to innovation. *Australian Journal of Public Administration, 52*(3), 292-304.

Ministry of Transport. (2013a). Draft government policy statement on land transport 2015 (Vol. 2013).

Ministry of Transport. (2013b). Statement of intent 2013-2016: Ministry of Transport.

Mitchell, R., Agle, B., & Wood, D. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Academy of management review, 22*(4), 853-886.

Moodley, K. (2015). Editorial. *Infrastructure Asset Management, 2*(1), 1 -2.

Murray, P. (1998). Complexity theory and the fifth discipline. *Systemic Practice and Action Research, 11*(3), 275-293.

Nadler, D., & Tushman, M. (1980). A model for diagnosing organizational behavior. *Organizational Dynamics, 9*(2), 35-51.

NAMS. (2007). *Developing levels of service and performance measures: Creating customer value from community assets*. Wellington.

NAMS. (2008-2015). Infrastructure asset management defined. Retrieved from http://www.nams.org.nz/pages/173/infrastructure-asset-management-defined.htm

NAMS. (2011). *International infrastructure management manual* (2011 ed.). Wellington.

National Infrastructure Unit. (n.d.). Better business cases-investing for change for better value. Retrieved from http://www.treasury.govt.nz/statesector/investmentmanagement/plan/bbc

Neely, A., & Bourne, M. (2000). Why measurement initiatives fail. *Measuring Business Excellence, 4*(4), 3-7.

Neville, B., Bell, S., & Whitwell, G. (2011). Stakeholder salience revisited: Refining, redefining, and refueling an underdeveloped conceptual tool. *Journal of Business Ethics, 102*(3), 357-378.

Neville, B., Menguc, B., & Bell, S. (2003). *Stakeholder salience reloaded: Operationalising corporate social responsibility.* Paper presented at the Australia and New Zealand Marketing Academy Conference, December 1.

New Zealand Government. (2011a). Government policy statement on land transport funding 2012/13-2021/22 (v 1.1 ed.). Wellington.

New Zealand Government. (2011b). *National infrastructure plan 2011*. Retrieved from http://www.infrastructure.govt.nz/plan.

New Zealand Productivity Commission. (2013). Boosting productivity in the services sector: Issues paper. Wellington.

New Zealand Treasury. (2011). Working towards higher living standards for New Zealanders (pp. 59). Wellington.

Newell, B., Crumley, C., Hassan, N., Lambin, E., Pahl-Wostl, C., Underdal, A., & Wasson, R. (2005). A conceptual template for integrative human–environment research. *Global environmental change, 15*(4), 299-307.

Newig, J., Günther, D., & Pahl-Wostl, C. (2010). Synapses in the network: Learning in governance networks in the context of environmental management. *Ecology & Society, 15*(4).

Nikander, P. (2008). Working with transcripts and translated data. *Qualitative Research in Psychology, 5*(3), 225-231.

NZTA. (2000). SM020: State highway asset management manual.

NZTA. (2009). Pavement condition surveys. Retrieved from http://www.nzta.govt.nz/network/maintaining/made-of/pavement-condition.html

NZTA. (2010). Cost estimation manual.

NZTA. (2011). State highway asset management plan 2012–2015.

NZTA. (2013a). Economic evaluation manual.

NZTA. (2013b). NZ Transport Agency statement of intent 2013-2016. Web: NZTA.

NZTA. (2013c). Procurement manual (Chapter 11: Performance measurement and monitoring).

NZTA. (2013d). SM030 Standard professional services specifications: Design and project documentation (Amendment 3 ed.).

NZTA. (2014a). NZ Transport Agency statement of intent 2014–18 (pp. 52): NZTA.

NZTA. (2014b). Walking in your shoes questionnaire. Retrieved from https://www.surveymonkey.com/survey-taken/?sm=y2HL0aQsskbwk9TfdhEkUYY%2bZvpG9yGM4j4RiuS6GCUi%2fzNQEg23D1QNcnKddszsZHFWaJeSdKOy9hOANk3R6w%3d%3d

NZTA. (2015a). Assessment Framework for 2015-18 NLTP. Retrieved from https://www.pikb.co.nz/assessment-framework

NZTA. (2015b). State highway performance: Customer surveys. Retrieved 23-24 March 2015

O'Connell, D., & Kowal, S. (1994). Some current transcription systems for spoken discourse: A critical analysis. *Pragmatics, 4*(1), 81-107.

OECD. (2012). Strategic infrastructure needs to 2030: Main findings *OECD International Futures Programme*: Organisation for Economic Co-Operation and Development.

Olmedo, E. (2010). Complexity and chaos in organisations: Complex management. *International Journal of Complexity in Leadership and Management, 1*(1), 72-82.

OMEGA Centre. (2012). Lessons for decision-makers: An analysis of selected international large-scale transport infrastructure projects *Mega projects* (Vol. Executive Summary, pp. 52). London: Bartlett School of Planning, University College London.

Opus International Consultants Ltd. (2008). AMETI project overview document (APOD).

Opus International Consultants Ltd. (2009). AMETI: Panmure phase scheme assessment (Vol. 1, pp. 188).

Opus International Consultants Ltd. (2015). AMETI Stage 1: Van Dammes Lagoon operation and maintenance plan.

Opus International Consultants Ltd, B. I. L., Brewer Davidson, PB. (2011). AMETI package 1 final design report.

Osterwalder, A. (2004). *The business model ontology: A proposition in a design science approach.* (PhD), l'Université de Lausanne.

Owens, S. (1995). From 'predict and provide' to 'predict and prevent'? Pricing and planning in transport policy. *Transport Policy, 2*(1), 43-49.

Oxford English Dictionary (online version). (2014). Retrieved from http://www.oed.com/

Pahl-Wostl, C. (2002). Towards sustainability in the water sector–The importance of human actors and processes of social learning. *Aquatic sciences, 64*(4), 394-411.

Pahl-Wostl, C. (2007). The implications of complexity for integrated resources management. *Environmental Modelling & Software, 22*(5), 561-569.

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global environmental change, 19*(3), 354-365.

Pahl-Wostl, C., Holtz, G., Kastens, B., & Knieper, C. (2010). Analyzing complex water governance regimes: the management and transition framework. *Environmental Science & Policy, 13*(7), 571-581.

Parasuraman, A., Zeithaml, V., & Berry, L. (1985). A conceptual model of service quality and its implications for future research. *Journal of marketing, 49*(4).

Parasuraman, A., Zeithaml, V., & Berry, L. (1994). Reassessment of expectations as a comparison standard in measuring service quality: implications for further research. *the Journal of Marketing*, 111-124.

Parker, M. (2016). The Rothschild Report (1971) and the purpose of government-funded R&D—A personal account. *Palgrave communications, 2*.

Parsons, W. (1995). Public policy. *Cheltenham, Northampton*.

Perrow, C. (1961). The analysis of goals in complex organizations. *American sociological review*, 854-866.

Pfeffer, J., & Salancik, G. (2003). *The external control of organizations: A resource dependence perspective*: Stanford University Press.

Piercy, N. F. (2009). Strategic relationships between boundary-spanning functions: Aligning customer relationship management with supplier relationship management. *Industrial Marketing Management, 38*(8), 857-864. doi:http://dx.doi.org/10.1016/j.indmarman.2009.03.015

Pohl, C., & Hirsch Hadorn, G. (2008). Methodological challenges of transdisciplinary research. *Natures Sciences Sociétés, 16*(2), 111-121.

Prahalad, C. K., & Gary Hamel. (2003). The core competence of the corporation. *harvard business review*, 17.

Propper, C., & Wilson, D. (2003). The use and usefulness of performance measures in the public sector. *Oxford Review of Economic Policy, 19*(2), 250-267.

Public Records Act, 2005 No 40 Stat. (2005).

Quinet, E. (2011). Cost–benefit indicators and transport programming. *Fiscal Studies, 32*(1), 145-175.

Rabah, I. (2015). Research Methods in Public Administration: A Critical Review of a Quantitative Article.

Radio New Zealand (Producer). (2012). New chair of Auckland Transport wants more focus on customers,. [Radio interview/MP3] Retrieved from http://podcast.radionz.co.nz/mnr/mnr-20121024-0748-new_chair_of_auckland_transport_wants_more_focus_on_customers-048.mp3

Ramdas, V., Thomas, C., Lehman, C., & Young, D. (2007). Highway service levels: TRL and Ipsos MORI.

Ramsden, I., & Spoonley, P. (1993). The cultural safety debate in nursing education in Aotearoa. *New Zealand Annual Review of Education, 3*, 161-174.

Reason, J. (1990). The contribution of latent human failures to the breakdown of complex systems. *Philosophical transactions of the Royal Society of London. Biological sciences, 327*(1241).

Reason, J. (1995). A systems approach to organizational error. *Ergonomics, 38*(8), 1708-1721.

Resource Management Act, Pub. L. No. 1991 No 69 (1991).

Robson, C. (2002). *Real world research* (2nd ed.). Malden, USA: Blackwell Publishing.

Ryan, G., & Bernard, H. (2003). Techniques to identify themes. *Field methods, 15*(1), 85-109.

Sammon, D., Adam, F., & Carton, F. (2003). Benefit realisation through ERP: The re-emergence of data warehousing. *Electronic Journal of Information Systems Evaluation, 6*(2), 155-164.

SC 82/2013 [2014] NZSC 38, Supreme Court of New Zealand. 89 (2014).

Schein, E. (2010). Three cultures of management: The key to organizational learning. *Global working. Living and working across the world with cultural intelligence, 37*.

Schindler, M., & Eppler, M. (2003). Harvesting project knowledge: A review of project learning methods and success factors. *International Journal of Project Management, 21*(3), 219-228.

Schön, D. (1991). *The reflective practitioner: How professionals think in action*. Aldershot: Ashgate Arena.

Seddon, J. (2008). *Systems thinking in the public sector: The failure of the reform regime...and a manifesto for a better way*: Triarchy Press Limited.

Seddon, J., & Brand, C. (2008). Debate: Systems thinking and public sector performance.

Seddon, J., & Caulkin, S. (2007). Systems thinking, lean production and action learning. *Action Learning: Research and Practice, 4*(1), 9-24.

Sehested, K. (2002). How new public management reforms challenge the roles of professionals. *International Journal of Public Administration, 25*(12), 1513-1537.

Senge, P. (2006). *The fifth discipline: The art and practice of the learning organization* (Second ed.). New York: Currency.

Simon, H. (1969). *The sciences of the artificial* (Vol. 136).

Simon, H. (1972). Theories of bounded rationality. *Decision and organization, 1*, 161-176.

Snowden, D. (2003). Complex acts of knowing: Paradox and descriptive self-awareness. *Bulletin of the American Society for Information Science and Technology, 29*(4), 23-28.

Snowden, D. (2005). Strategy in the context of uncertainty. *Handbook of Business strategy, 6*(1), 47-54.

Snowden, D., & Boone, M. (2007). A leader's framework for decision making. *harvard business review, 85*(11), 68.

Solomon, M. (2014). How To Think Like Apple About The Customer Service Experience. *Business Intelligence: Trends for 2017*. Retrieved from https://www.forbes.com/sites/micahsolomon/2014/11/21/how-apple-thinks-differently-about-the-customer-service-experience-and-how-it-can-help-you/#46d60a627c99

Star, S. (1999). The ethnography of infrastructure. *American behavioral scientist, 43*(3), 377-391.

State Services Commission. (2010). Gateway review process best practice-gateway to success (Vol. Review 2 delivery strategy - detailed business case). Wellington: New Zealand Government.

State Services Commission. (2013a). Gateway review process best practice-gateway to success (Vol. Review 0 strategic assessment). Wellington: New Zealand Government.

State Services Commission. (2013b). Gateway review process best practice-gateway to success (Vol. Review 1 business justification & options-indicative business case). Wellington: New Zealand Government.

State Services Commission. (2013c). Gateway review process best practice-gateway to success (Vol. Review 5 operational review and benefits realisation). Wellington: New Zealand Government.

State Services Commission. (2013d). Gateway review process best practice-gateway to success (Vol. Review 4 readiness for service). Wellington: New Zealand Government.

State Services Commission. (2013e). Gateway review process best practice-gateway to success (Vol. Review 3 investment decision). Wellington: New Zealand Government.

Statistics New Zealand. (2013a). 2013 Census. Retrieved 17 February 2015 http://www.stats.govt.nz/Census/2013-census.aspx

Statistics New Zealand. (2013b). Auckland fastest-growing region since last census, and South Island districts grow most. Retrieved from http://www.stats.govt.nz/browse_for_stats/population/census_counts/2013CensusUsuallyResidentPopulationCounts_MR2013Census.aspx

Statistics New Zealand. (2014). New Zealand's regional economies 2013–infographic. Retrieved from http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/rgdp-2014-graphic.aspx

Stock, P., & Burton, R. J. (2011). Defining terms for integrated (multi-inter-trans-disciplinary) sustainability research. *Sustainability, 3*(8), 1090-1113.

Stokols, D. (2006). Toward a science of transdisciplinary action research. *American journal of community psychology, 38*(1-2), 63-77.

Straub, R. (2013). Why managers haven't embraced complexity. Retrieved from http://blogs.hbr.org/2013/05/why-managers-havent-embraced-c/

Sutcliffe, K. (2011). High reliability organizations (HROs). *Best Practice & Research Clinical Anaesthesiology, 25*(2), 133-144.

Syntetos, A., & Jackson, M. (2011). The multi-methodology debate: A response to Harwood. *The Journal of the Operational Research Society, 62*(4), 811-813.

Taleb, N. (2012). *Antifragile: Things that gain from disorder*. New York: Random House.

The Institute of Asset Management. (2008). PAS 55-1:2008 Asset management part 1: Specification for the optimization of physical assets: British Standards.

The Treasury. (2015a). Better business cases: Guide to developing an indicative business case. Wellington: New Zealand Government.

The Treasury. (2015b). Better business cases: Guide to developing the strategic assessment. Wellington: New Zealand Government.

The World Bank. (1998). Public expenditure management handbook. Washington DC, USA.

Thiry, M., & Deguire, M. (2007). Recent developments in project-based organisations. *International Journal of Project Management, 25*(7), 649-658.

Thomas, A. (2004). *Research skills for management studies*: Routledge.

Tillmann, P., Tzortzopolous, P., Sapountzis, S., Formoso, C., & Kagioglou, M. (2012). A case study on benefits realisation and its contributions for achieving project outcomes. *Proceedings of the 20th IGLC*.

Transfund New Zealand. (1997). RAMM: Road condition rating and roughness manual (PFM6).

Trumbo, J. (1999). Visual literacy and science communication. *Science communication, 20*(4), 409-425.

Turley, F. (2010). The PRINCE2® foundation training manual: A practical approach to passing the PRINCE2® foundation exam (1.0d ed.): MgmtPlaza.

Tyre, M. J., & Orlikowski, W. J. (1994). Windows of opportunity: Temporal patterns of technological adaptation in organizations. *Organization Science, 5*(1), 98-118.

Uhl-Bien, M., & Marion, R. (2008). *Complexity leadership part 1: Conceptual foundation*: Information Age Publishing.

Uhl-Bien, M., Marion, R., & McKelvey, B. (2007). Complexity leadership theory: Shifting leadership from the industrial age to the knowledge era. *The Leadership Quarterly, 18*(4), 298-318.

Van de Ven, A. H. (1976). A framework for organization assessment. *Academy of management review, 1*(1), 64-78.

van der Lei, T., Herder, P., & Wijnia, Y., (Eds.). (2012). *Asset management: The state of the art in Europe from a life cycle perspective*. Delft: Springer.

Van Maanen, J., & Barley, S. R. (1982). Occupational communities: Culture and control in organizations: DTIC Document.

Van Themsche, S. (2016). Avoiding megacities' standstill *The advent of unmanned electric vehicles* (pp. 237-282): Springer.

Versus Research. (2013). Annual customer views survey report: Matamata-Piako District Council.

von Neumann, J., & Morgenstern, O. (2007). *Theory of games and economic behavior (60th anniversary commemorative edition)*: Princeton university press.

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management, 22*(2), 195-219.

Walshe, K., Harvey, G., & Jas, P., (Eds.). (2010). *Connecting knowledge and performance in public services: From knowing to doing*: Cambridge University Press.

Walshe, K., Harvey, G., Skelcher, C., & Jas, P. (2009). Could do better? *Knowledge, Learning and Performance improvement in public services, Report to the ESRC Public Services Programme, Universities of Manchester & Birmingham*.

Weber, M. (1958). *The city* (D. M. a. G. Neuwirth, Trans. D. M. a. G. Neuwirth Ed.). New York: The Free Press.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science, 16*(4), 409-421.

Whittington, R. (2006). Completing the practice turn in strategy research. *Organization studies, 27*(5), 613-634.

Wickson, F., Carew, A. L., & Russell, A. W. (2006). Transdisciplinary research: Characteristics, quandaries and quality. *Futures, 38*(9), 1046-1059.

Wilson, W. (1887). The study of public administration. *Political Science Quarterly, 2*, 197-222.

Winter, M., Smith, C., Morris, P., & Cicmil, S. (2006). Directions for future research in project management: The main findings of a UK government-funded research network. *International Journal of Project Management, 24*(8), 638-649.

Yankelovich, D. (1991). *Coming to public judgment: Making democracy work in a complex world*: Syracuse University Press.

Yankelovich, D., & Friedman, W. (2010). *Toward wiser public judgment*: Vanderbilt University Press.

Yin, R. (1981). The case study crisis: Some answers. *Administrative Science Quarterly, 26*(1), 58-65.

Yin, R. (2003). *Case study research: Design and methods* (3 ed. Vol. 5). California: Sage Publications.

Yu, H., & Bower, J. (2009). Taking a “deep dive”: What only a top leader can do *Working Paper 09-109*: Harvard Business School.

Zimmerman, R., & Sparrow, R. (1997). Workshop on integrated research for civil infrastructure.

APPENDICES

APPENDIX I: NEW ZEALAND CONTEXT

Land transport context

Land transport in the New Zealand context is the infrastructure, goods, and services facilitating transport on land by any means (Part 1, s5; Land Transport Management Act (LTMA), 2003). National land transport strategies are guided and informed by a range of government policy documents, central to which is *Government Policy Statement on Land Transport Funding* (Ministry of Transport, 2013a; New Zealand Government, 2011a). Although some integration will occur, land transport activities at the national level tend to be addressed by mode (New Zealand Government, 2011a, 2011b) and the focus at the present time is largely upon those that are road related. That emphasis is reflected in this research.

The NZTA is the central entity, as it (Ministry of Transport, 2013b):

- allocates funding for land transport infrastructure and services through the National Land Transport Programme;
- manages access to the transport system through driver and vehicle licensing, vehicle inspections and rules development;
- provides land transport safety and sustainability information and education; and
- manages the State highway network, including maintenance, improvements and operations activities.

Local authorities own, maintain, and develop the local road network and perform important regulatory functions. Local government funds land transport infrastructure and public transport services alongside central government and is responsible for transport planning and land use planning. Some local authorities also own seaports and airports, or share ownership with the Crown or private companies.

Consideration of the roading framework alone would be sufficient for many parts of New Zealand, but both Auckland and Wellington also have commuter rail systems operated by local government on (mostly) national rail assets. Auckland, Wellington, and Christchurch also have ferry services that form part of the local transport system. Furthermore Auckland has a specific and (at this time) unique local government framework which includes a separate entity accountable for transportation management within the region.

Auckland is New Zealand's largest city. Relatively recently established from an amalgamation process of one regional and seven local councils (Local Government (Auckland Council) Act (LGA$_{(AC)}$), 2009), the 'super city' covers the entire Auckland region of approximately 1.4M people (Statistics New Zealand, 2013b). The amalgamation occurred three years prior to the start of this research, so provided an insight into recent practice from across the eight 'legacy' organisations.[167]

Under its enabling legislation, accountability for the Auckland transport system[168] rests with Auckland Transport, a Council Controlled Organisation (s39; LGA$_{(AC)}$, 2009). Whilst many of the regional accountabilities rest with Auckland Transport, a 'one system' approach with the State highway network is required (s38AA; LTMA, 2003). Auckland Transport also differs from many other local government structures, due largely to its establishment as a body corporate and the inclusion of a board of directors (s38(2)(a), s43; LGA$_{(AC)}$, 2009).

Along with Auckland's scale and complexity, the amalgamation provides a unique opportunity to canvass practices selected or adapted from a number of local authorities. It should also reduce the likelihood of defensive or blaming behaviours as staff may not have so much 'ownership' of past processes and projects. Moreover, the organisation is also actively seeking to improve its practice and so was open to this research.

Lastly, New Zealand's land transport context is also part of, and influences, international practice. This includes close ties with the Australasian practice group

[167] New Zealand has 78 local authorities (Department of Internal Affairs, 2011): 11 regional councils and 67 territorial authorities (i.e. unitary authorities, city and district councils).

[168] This includes local roads, public transport infrastructure and services, and excludes State highways, rail controlled by KiwiRail, some airports, and aspects of Council controlled off-street parking. For completeness, sea and air ports, and local ferry interfaces are considered as land transport nodes.

AustRoads, and the New Zealand centre for National Asset Management Support (NAMS), which includes an international practice group.

Wider context

The operation and management of land transport obviously sits within the wider context of other legislation and national strategies. Key strategic plans are defined in Law and so are common to those land transport organisations that fall within the jurisdiction of a given piece of legislation (e.g. "Land Transport Management Act," 2003; "Local Government (Auckland Council) Act," 2009; "Local Government Act," 2002; "Resource Management Act," 1991). This establishes a hierarchy of the various statutory and planning instruments (e.g. policies, plans, etc.) in which ‘lower order’ requirements are required to give effect to ‘higher order’ ones, with increasing specificity (e.g. see *SC 82/2013 [2014] NZSC 38*, 2014).

Much of the other detail is not immediately germane to this research, or is more appropriate to address in the context that it arises, with the following exceptions:

- **Ministry of Works and Development (MoW):**
  The country’s need for infrastructure development gave rise to centralised project and delivery-led agencies. These included the MoW, which was responsible for the design and construction of much of the significant public works and infrastructure until its dissolution in 1988. Many of the organisations responsible for public infrastructure in New Zealand today tend to be strongly engineering led, and retain this project delivery focus. However, there are signs that this is starting to change (NZTA, 2014a; Radio New Zealand, 2012).

- **New Zealand Treasury initiatives:**
  The Treasury of the New Zealand Government has several initiatives that either inform or relate directly to infrastructure. These include:
  - ‘*Working towards higher living standards for New Zealanders*’ (New Zealand Treasury, 2011).
  - The establishment of the National Infrastructure Unit, which co-ordinated the development of the ‘*National Infrastructure Plan*’ (New Zealand Government, 2011b), together with supporting initiatives such as the *Better*

Business Case framework (National Infrastructure Unit, n.d.) and work on infrastructure resilience (Fairclough, 2012, 2014).

Although the National Infrastructure Plan focuses on infrastructure by sector, many of the other initiatives encourage a broader, more holistic approach with the aim of improving outcomes more generally.

- **Sustainable management of resources:**
  The Resource Management Act (RMA), 1991, affects the management and operation of infrastructure. More particularly, new infrastructure is often predicated on the basis of it meeting the underlying purpose and principles of the Act; the purpose being "*to promote the sustainable management of natural and physical resources*" (s.5(1)).

APPENDIX II: SUMMARY OF INTERVIEWS AND WORKSHOPS

AII.1 Preliminary research

AII.1.1 Summary of preliminary interviews

The following table provides a summary of the interviews conducted as part of the preliminary research (Chapter 3 and cross-referenced throughout the document). To retain interviewee confidentiality, this includes the current level of responsibility/role of each interviewee and the type of organisation only. In some cases an individual may hold secondary/other roles (e.g. with industry/professional organisations or within governance), and of course an individual's experience may have crossed sectors, organisation type, and/ or country over time (for example). As noted in Section 3.1, it cannot be assumed, therefore, that an individual's response relates to their current role or organisation type because the interviews were canvassing experiences within the infrastructure industry generally. Moreover, some individuals were purposefully approached because of the breadth of their experience. A separate summary of interviewee experiences is provided in Section AII.1.2; this has not been linked to role and organisation type because, as discussed later, this was found to breach confidentiality.

Note: Interviewee numbers are non-sequential as not everyone listed in the underlying schedule was able to be interviewed.

Interview date	**Interview number**	**Interviewee location** *(does not infer nationality)*	**Principal interviewee role/level of responsibility**	**Principal interviewee organisation type**
Stage 1: General interviews				
5/12/2013	[PR13]	EU	Executive[169]	Research org[n]
6/1/2014	[PR14]	NZ	Executive	Government dep[t][170]

[169] Includes Board, CEO, Executive management (including non-governance Director roles as might exist within a consultancy, for example), Judicial Officer, and Senior Academic (Professor).

Interview date	**Interview number**	**Interviewee location** *(does not infer nationality)*	**Principal interviewee role/level of responsibility**	**Principal interviewee organisation type**
8/1/2014	[PR15]	NZ	Executive	Financing orgn
10/1/2014	[PR16]	NZ	Manager[171]	Infrastructure orgn
22/1/2014 and 25/3/2014	[PR18]	NZ	Executive	Industry orgn
31/3/2014	[PR19]	NZ	Executive	Infrastructure orgn
18/3/2014	[PR20]	NZ	Executive	Infrastructure orgn
25/3/2014	[PR21]	NZ	Manager	Infrastructure orgn
25/3/2014	[PR22]	NZ	Executive	Infrastructure orgn
31/3/2014	[PR24]	NZ	Executive	Infrastructure orgn
4/4/2014	[PR25]	NZ	Executive	Consulting orgn
26/3/2014	[PR26]	NZ	Team[172]	Infrastructure orgn
28/3/2014	[PR27]	NZ	Executive	Infrastructure orgn
28/3/2014	[PR28]	NZ	Executive	Consulting orgn
3/4/2014	[PR29]	NZ	Team	Government dept
2/4/2014	[PR30]	NZ	Executive	Infrastructure orgn

[170] Government departments include central government ministries and departments such as the Ministry of Transport (see Appendix I), but excludes those infrastructure organisations that are State owned enterprises (e.g. KiwiRail) which have been classified within this table as an 'infrastructure organisation'. The examples given within this footnote do not necessarily indicate a relationship to the actual interviews.

[171] Includes team/organisational management, project management.

[172] Includes team leaders, technical specialists, and senior advisors.

Interview date	**Interview number**	**Interviewee location** *(does not infer nationality)*	**Principal interviewee role/level of responsibility**	**Principal interviewee organisation type**
1/4/2014	[PR31]	NZ	Team	Government dept
2/4/2014	[PR32]	NZ	Manager	Infrastructure orgn
2/4/2014	[PR33]	NZ	Executive	Infrastructure orgn
2/4/2014	[PR34]	NZ	Executive	Infrastructure orgn
2/4/2014	[PR35]	NZ	Team	Infrastructure orgn
3/4/2014	[PR36]	NZ	Manager	Infrastructure orgn
1/4/2014	[PR37]	NZ	Team	Industry orgn
3/4/2014	[PR38]	NZ	Team	Infrastructure orgn
3/4/2014	[PR39]	NZ	Manager	Government dept
11/4/2014	[PR40]	NZ	Retired (Manager)	Infrastructure orgn
15/4/2014	[PR41]	NZ	Executive	Consulting orgn
11/4/2014	[PR42]	NZ	Executive	Infrastructure orgn
15/4/2014	[PR43]	NZ	Executive	Contracting orgn
11/4/2014	[PR44]	NZ	Executive	Consulting orgn
7/5/2014	[PR45]	EU	Executive	Research orgn
8/5/2014	[PR46]	EU	Manager	Infrastructure orgn
15/5/2014	[PR47]	EU	Executive	Infrastructure orgn
11/4/2014	[PR48]	NZ	Manager	Infrastructure orgn
23/5/2014	[PR49]	EU	Manager	Consulting orgn
2/6/2014	[PR50]	EU	Executive	Consulting orgn
7/6/2014	[PR51]	EU	Executive	Consulting orgn
7/6/2014	[PR52]	EU	Team	Consulting orgn
16/9/2014	[PR70]	NZ	Executive	Government dept

Interview date	**Interview number**	**Interviewee location** *(does not infer nationality)*	**Principal interviewee role/level of responsibility**	**Principal interviewee organisation type**
Stage 2: New Zealand transport sector-specific interviews				
21/8/2014 and 27/11/2014	[PR16]	NZ	Manager	Infrastructure org^{n}
21/8/2014	[PR53]	NZ	Manager	Infrastructure org^{n}
2/9/2014	[PR54]	NZ	Manager	Infrastructure org^{n}
16/9/2014	[PR55]	NZ	Executive	Infrastructure org^{n}
17/9/2014	[PR56]	NZ	Executive	Infrastructure org^{n}
16/9/2014	[PR57]	NZ	Executive	Infrastructure org^{n}
2/10/2014	[PR58]	NZ	Executive	Infrastructure org^{n}
16/9/2014	[PR59]	NZ	Manager	Infrastructure org^{n}
2/9/2014	[PR60]	NZ	Manager	Infrastructure org^{n}
21/8/2014	[PR61]	NZ	Manager	Infrastructure org^{n}
18/8/2014	[PR62]	NZ	Team	Infrastructure org^{n}
18/8/2014	[PR63]	NZ	Manager	Infrastructure org^{n}
19/8/2014	[PR64]	NZ	Manager	Infrastructure org^{n}
30/10/2014	[PR65]	NZ	Manager	Infrastructure org^{n}
2/9/2014	[PR66]	NZ	Manager	Infrastructure org^{n}
16/9/2014	[PR67]	NZ	Team	Infrastructure org^{n}
20/8/2014	[PR68]	NZ	Manager	Infrastructure org^{n}
21/8/2014	[PR69]	NZ	Manager	Infrastructure org^{n}

AII.1.2 Summary of preliminary interviewee experiences

Note: Many interviewees held more than one position at the time of the preliminary research interviews and/or were drawing upon previous roles and experiences. Accordingly, this summary cannot be directly linked to the number of interviewees.

Aspect	Interviewee location (does not infer nationality)	
	NZ	EU
Sector		
Social Infrastructure		
Recreation	✓	✓
Healthcare/public health	✓	✓
Education	✓	
Energy		
Generation	✓	
Transmission	✓	
Distribution	✓	
Transport		
State highway	✓	✓
Local roads	✓	✓
Rail	✓	✓
Public transport	✓	✓
Sea and air ports	✓	✓
Telecommunications	✓	
Waters		
Water	✓	✓
Wastewater	✓	✓
Stormwater	✓	

Aspect	**Interviewee location** *(does not infer nationality)*	
	NZ	**EU**
Sector *(Cont[d.])*		
Wastes	✓	
Defence	✓	
Role		
Central government	✓	
Funding & finance	✓	✓
Statutory	✓	
Political	N/A	N/A
Governance	✓	✓
Client	✓	✓
Consultant	✓	✓
Contractor	✓	✓
Stakeholders	✓	✓
Director	✓	✓
Manager	✓	✓
Team	✓	
Policy and strategy	✓	✓
Asset management	✓	✓
Project delivery	✓	✓
Operations	✓	✓
Compliance/audit	✓	✓
Industry organisation	✓	✓
Emergency preparedness	✓	

Aspect	**Interviewee location** *(does not infer nationality)*	
	NZ	**EU**
Role *(Cont[d])*		
Aid	✓	✓
Academia/research	✓	✓
Discipline		
Engineering	✓	✓
Sciences	✓	✓
Planning	✓	✓
Law	✓	✓
Other arts	✓	
Finance and business	✓	
Other expertise (e.g. cultural)	✓	
Context (NZ only)		
Ministry of Works (MoW)	✓	
Post MoW (1988+)	✓	
Location		
Auckland	✓	
New Zealand	✓	✓
Australia	✓	✓
Pacific Islands	✓	✓
Greater Asia	✓	✓
Europe and UK	✓	✓
Americas	✓	
Africa	✓	✓
Other/unspecified	✓	✓

The summary of interviewee experience has not been linked with the details provided within Section AII.1.1 to protect the confidentiality of those interviewed. To test this, a summary matrix was provided to two senior industry practitioners in New Zealand. The summary *only* included interview date and matrix of experiences for each interviewee. No interview number or other identifying parameters such as name, organisation, or position were included. The scrutineers were not given feedback on who had been correctly identified.

Excluding any self-identification, the scrutineers were able to identify:

- two people correctly (confirming that a breach in confidentiality would likely result from a more detailed matrix); and also
- six people who had been interviewed, but whose name placement didn't align with the underlying spreadsheet (i.e. where individuals have similar experience, this would give rise to a perceived confidentiality breach and risk quotes being wrongly attributed).

AII.2 Summary of detailed study 1 interviews and workshops

Date	Number	Interviewee role/level of responsibility	Interviewee organisation
Semi-structured interviews			
17/4/2015	[DS1.1]	Executive	Auckland Transport
6/8/2015	[DS1.2]	Manager	Auckland Transport
1/9/2015	[DS1.3]	Director	Consultant
1/9/2015	[DS1.4]	Manager	Consultant
18/9/2015	[DS1.5]	Programme Director	Auckland Transport
23/9/2015	[DS1.6]	Senior Advisor	Consultant
4/11/2015	[DS1.7]	Executive (x2)	Office of the Auditor General
Influencing change workshop			
31/8/2016	[DS1.8]	Manager (x2)	Auckland Transport

AII.3 Summary of detailed study 2 interviews and workshops

Date	Number	Interviewee role/level of responsibility	Interviewee organisation
Semi-structured interviews			
See AII.2 (AMETI discussions were common to both studies)			
Additional meetings and discussions			
30/3/2015	[DS2.1]	Asset Manager	Auckland Transport
19/6/2015	[DS2.2]	Asset Manager	Auckland Transport
24/9/2015	[DS2.3]	Asset Manager	Auckland Transport
14/12/2015	[DS2.4]	Asset Manager	Auckland Transport
12/1/2016	[DS2.5]	Asset Manager and Programme Director	Auckland Transport
13/1/2016	[DS2.6]	Finance/Commercial Manager	Auckland Transport
14/3/2016	[DS2.7]	Programme Director	Auckland Transport
14/3/2016	[DS2.8]	Asset Manager	Auckland Transport
cOPEX workshop			
18/12/2015	[DS2.8]	Asset Manager.	Auckland Transport
Influencing change workshop			
2/9/2016	[DS2.9]	Manager (x2)	Auckland Transport

AII.4 Summary of detailed study 3 interviews and workshops

Note: Performance management emerged very early within the preliminary interviews as a key issue.[173] This is unsurprising in the context of New Public Management and infrastructure practice, particularly in New Zealand where the majority of the preliminary interviews were conducted. As explained (Section 4.4.1, Appendix III), the detailed studies needed to be ring-fenced quickly when opportunities arose and resulted in some overlapping of the preliminary research with the initial work undertaken for this particular study. Had the final analysis changed the emphasis, then this work would have been set aside; however, this did not eventuate and more than compensated for the risk of rework.

Date	Number	Role/level of responsibility	Organisation
Preliminary discussion by phone/email regarding the current measure and approach			
Sept 2013	[DS3.1]	Manager	Auckland Transport
Sept 2013	[DS3.2]	Manager	Auckland Transport
Sept 2013	[DS3.3]	Manager	Whangarei District Council
2/10/13	[DS3.4]	Manager	Dunedin City Council
Sept 2013	[DS3.5]	Manager	NZTA (Christchurch)
Sept 2013	[DS3.6]	Manager	NZTA (National)
Date	**Number**	**Participant description**	
Customer workshops			
26/8/2014	[DS3.7]	Napier. 12 participants: ▪ Freight company (x2) ▪ Regional council / walking school bus ▪ Emergency services (New Zealand Police, New Zealand Fire Service) ▪ Residents groups (x3; 2 retirees) ▪ Public transport provider (bus)	

173 e.g. [PR14-PR16], [PR18-PR21], [PR24-PR39], [PR41-PR51].

Date	Number	Role/level of responsibility	Organisation
		▪ Blind Foundation ▪ Automobile Association (NZTA staff member at request of Association) ▪ Cycle advocacy group	
28/8/2014	[DS3.8]	Christchurch: 10 participants: ▪ Living streets / District health board ▪ New Zealand Trucking Association ▪ SPOKES (cycling advocacy) ▪ New Zealand Blind Foundation ▪ Age Concern ▪ Health Policy Advisors/accessibility and wheelchair user advocate ▪ Resident groups (x4; interests in local major projects and covering a range of modes and urban/rural areas)	
29/8/2014	[DS3.9]	Dunedin: 6 participants: ▪ New Zealand Police ▪ Accessibility and wheelchair user advocate ▪ NZTA (x2; as resident customers covering a range of modes) ▪ Cycle advocacy group	
Influencing change workshop: NZTA			
9/4/2015	[DS3.10]	7 participants from across the organisation (e.g. asset management, journey management, network directions and performance, customer services).	
Influencing change workshop: Auckland Transport			
14/8/2015	[DS3.11]	10 participants from across the organisation (e.g. asset management, walking and cycling, performance management)	

APPENDIX III: RESEARCH MANAGEMENT

Research and data management tools were established to assist the research process. In addition to physical systems such as filing architecture, backup systems and data matrices:

- Attention was given to ethical matters, including:
  - Completion of a self-declaration style check-list to appraise risks and issues that might arise from the research process.
  - Obtaining informed consent[174] from each of the interviewees and retaining a copy or note of this on file.
  - Obtaining executive-level approval from the two study organisations.
  - Clarifying the voluntary and confidential nature of workshops and surveys.
  - Forwarding compliance and specific safety issues identified within the detailed studies.

- Early consideration was given to the question of data transcription and analysis. For process transparency, a set of criteria[175] were developed and kept on record.
- Referencing systems were developed for source material (and are as used in this document):
  - workshop participant (not individually identified): [WP];
  - preliminary research interviewee: [PRx];[176]
  - survey respondent: [SRx]; and
  - Auckland Transport source document [ATx].

[174] Either in writing or verbally (e.g. for phone interviews).

[175] Based upon a review of Bryman and Bell (2011); Denscombe (2011); Flick (2002); McLellan, MacQueen, and Neidig (2003); Nikander (2008); O'Connell and Kowal (1994); Robson (2002).

[176] Note that the annotation system results in numbers exceeding the given number of interviews.

The study organisations, themselves, changed over the course of the research. This required both an opportunistic approach to the identification of the detailed studies (once key issues and themes had been identified through the preliminary research), and ongoing adaptation, flexibility and research management. Organisational changes included organisational restructuring, and reaction to the research itself.

APPENDIX IV: LIFECYCLE INTERFACE FACTORS

Note: The removal of words as well as transcribed stuttering, restarts, and other verbal ticks are indicated by […]*.*

Aspect *(Lifecycle interface)*	**Contributing factors with example comments** *Note: Quotes may contain more than one issue. Not all quotes relating to an aspect or factor are included.*
Strategy–project interface	***Articulating benefits***
	▪ *"What* […] *is infrastructure there to serve? It's there* […] *to deliver social and economic development* […] *and sustainable outcomes. And so if those are the objectives that we are wanting, that's where we should start."* [PR18; on project development] ▪ *"We are so focused on oversight, sometimes we dabble in foresight, but so little do we actually enter the place of insight. And the problem about insight is it is really in the generative space, so* […] *most boards* […] *by the time that they see a paper, a proposal, a plan, the opportunity for generativity is mainly gone* […] *So you're just kind of mainly forced into an oversight, you know?* [… …] *If that's the only role we play, we land up with the poorly thought through, over engineered, expensive pieces of infrastructure that fail to truly deliver to our purpose."* [PR58]
	Business case boundaries
	▪ *"It's actually* […] *making sure you* […] *build what you actually need, not what the accountants think you can get away with."* [PR41] ▪ *Yeah, boy those are hard questions* […] *So when businesses make infrastructure investments* […] *there's a life put into the business case — do they think beyond that? No."* [PR42]
	Lock-in/momentum/prioritisation
	▪ *"We're still implementing some projects that've been in the system for quite some time. So we're still* […] *building the old system*

Aspect *(Lifecycle interface)*	**Contributing factors with example comments** *Note: Quotes may contain more than one issue. Not all quotes relating to an aspect or factor are included.*
	while we're trying to invent a new one [... ...] *So in other words we've got* [sector] *projects* [that] *presumably are seen as past the point of no return* [...] *but* [...] *I think it's questionable* [...] *whether they should be priorities in the new environment* [... ...] *we're continuing to build the city* [...] *in the way in which it's been developed for the last 50 years* [...] *I'm probably being a little bit unfair because I mean there are plenty of signs that things are starting to —but you know, it's a bit like turning* [...] *an ocean liner* [...] *it's a very long, slow process to change direction."* [PR60]
	Follow-through/ reconciliation with system-level objectives (feed-forward)
	▪ *"Clearly there are some* [...] *classic examples of where things have been found wanting —but in retrospect* [gives examples…] *These are all very specific examples but* [...] *they all illustrate that* [...] *things haven't* [...] *all —well things have been thought about usually —but they haven't always been followed through."* [PR50] ▪ *"The capital development part of the business believes it knows what it needs to build, and is reluctant to always be guided by the client, which is —oh* [...] *it frustrates me because* [... ...] *that's actually a key barrier at the moment to getting the right outcomes."* [PR53]
Project–operational interface	***Handover (feed-forward)***
	▪ *"I think stories are not obvious with infrastructure at large, and* [...] *there are hidden elements that without some explanation will be missed in everyday management* [...] *Being able to tell a comprehensive story in perhaps a structured, but at least simple form* [...] *can provide the understanding that a visual inspection won't* [... ...]*Our design reports have a tendency to have been written for the purposes of gaining consent or funding approval and are written to the specifications of the consenting body or the*

Aspect *(Lifecycle interface)*	**Contributing factors with example comments** *Note: Quotes may contain more than one issue. Not all quotes relating to an aspect or factor are included.*
	funding body […] *and* …] *the* […] *basic design intent may be lost in the welter of information that is needing to be provided in a particular form."* [PR62] ▪ *"Asset engineers get given a package at the end of the job, and it's usually a* […] *whopping great big package and we all say we read them and* [that] *you know every single line and understand every nuance of that project but* […] *we're largely given it at the end. So we don't know all the nuances and everything else and the thinking that went behind it* […] *So the maintenance* […] *engineers change, you know* […and] *someone else comes along and goes oh well 'what a stupid* [thing to do]*, I'm going to* [do something different]*'."* [PR16]
	Transition from asset to system
	▪ "*If* [a third party doesn't] *do their associated projects —well that's really naff! And you know* […] *then you think, well that's only* […] *happened in the last five years* […] *before then, we'd built a massive project* […] *then you know, they'd just go and create* [an adverse local effect]*, well that's stupid isn't it?* [PR33] ▪ *"When the new projects are created, they don't necessarily consider the overall* […] *lifecycle impacts, or the whole-of-life cost* […] *I mean for the best reasons, everyone is interested in creating something because that's the exciting thing, isn't it? But* […] *you tend to forget about your consequential OPEX or your operational requirements, and renewal requirements* […]*"* [PR63] ▪ ***"… do we cope well with projects coming into…*** *No.* ***…a wider system?*** *No* [… …] *The interface there is poor* [… …] *In fact it's non-existent around our current projects."* [PR66]

<table>
<tr><th>Aspect

(Lifecycle interface)</th><th>Contributing factors with example comments

Note: Quotes may contain more than one issue. Not all quotes relating to an aspect or factor are included.</th></tr>
<tr><td></td><td>Whole-of-life performance</td></tr>
<tr><td></td><td>
“[We’ve] got to look at the long term consequences —not so much in cost terms because all the economists want you to discount future costs away and when you get out that far they get to zero sort of thing —but more from the point of view of the concept of future generations inheriting ‘this thing’ and what are you going to do with it! Whether it can be maintained and serviced or whether it has to be removed —whatever. So there needs to be a practicality issue there…some consideration.” [PR14]
“It’s not built into […] the business casing […] that space […] I think will improve over time, but […] it definitely is not […] in there and you know you do see some […] classic […] issues that come up ‘cos there just hasn’t [been] that sort of holistic […] view” [PR15; on interface between strategy, projects, and operations]
“A lot of the capital development justification is framed around benefits, but a lot of those benefits can only be realised through proper maintenance and operations. And if we […] can’t fund proper maintenance and operations, does that question why we’re doing the development in the first place?” [PR16]
</td></tr>
<tr><td>Operational–strategy interface</td><td>Performance (benefit) monitoring</td></tr>
<tr><td></td><td>
“…do you think those benefits are being captured well…? Um, ah, not as well as we could […] if you can’t measure the value, you will never know what the real value is.” [PR20]
“I think that whole thing of benefit monitoring [is] an area that we really, really should be spending more time and effort on […] it’s so powerful ‘cos you can stand up there when people are thinking about investing in new things and saying ‘ooohhh, we don’t think […] that people’re gonna behave that way, you’re never gonna get so many people shifting over’ and you can put up this graph and say […] we did it then and look what happened!” [PR57]
</td></tr>
</table>

Aspect *(Lifecycle interface)*	**Contributing factors with example comments** *Note: Quotes may contain more than one issue. Not all quotes relating to an aspect or factor are included.*
	▪ *"I mean we try to take a whole-of-life of view of our infrastructure* [...] *you know, what are we building and how're we building it, right through to the decommissioning and making sure that it's safe and doesn't leave a contingent liability out there* [...] *but in the middle we've got the operations and maintenance bit* [...]*"* [PR34; on resilient outcomes]
	Follow-through/reconciliation with system-level objectives. Feedback to strategy (above)
	▪ *"I guess in my mind I've seen them as two separate entities —you* [...] *build something and then you let somebody else come along and play and* [...] *manage it."* [PR24; on strategic planning and operations] ▪ "*We've got to be intelligence led, we've got to have a capability around turning —we…have bucket-loads of data. We* [...] *are not short of data* [...] *We* [...] *can turn it into information. We can tell people. That's easy. But we're not good at turning it into intelligence*." [PR36] ▪ "*Then the other gap* […] *is the* […] *feedback loop* [...there's] *a long way to go* […] *that's probably the least developed, and we…have started some conversations with our delivery groups…and we want to enhance those processes*." [PR63]

APPENDIX V: AMETI OVERVIEW

The Auckland-Manukau Eastern Transport Initiative (AMETI) is a major, multimodal programme aimed at improving strategic transport links in the east of Auckland (Figure AV.1). It comprises (Auckland Transport, 2013b, p. 48):

> *An integrated package of improvements to all transport modes in the Panmure area, designed to improve the transport choices so as to reduce dependence on private car use and facilitate land use changes to improve the area economically, socially and environmentally.*

Figure AV.1: AMETI staging plan

Source: Auckland Transport (2015a)

Note: AMETI stage 1 (Panmure station and approaches) only has been considered as part of this research.

The programme is divided into several stages, the first of which, was completed in 2014. The main components of Stage 1 (or 'the project') include (Ibid.):

- the reconstruction of two road bridges and one footbridge;
- construction of a covered box structure (accommodating the rail station and link road), plus an additional pedestrian/service vehicle bridge;
- a local road realignment;
- construction of a new link road (Te Horeta Road);
- upgrades to an existing rail station, creation of a new rail/bus interchange, and the addition of new bus lanes;
- improvements to walking and cycling facilities;
- establishment of public open spaces, park and ride facilities, and environmental mitigation works including noise wall construction, improvements to coastal outfalls, stream 'daylighting', and the rehabilitation of a wetland lagoon (integrated with stormwater management).

At the time this research commenced, AMETI was the largest programme under construction for Auckland Transport and one of the largest transportation projects of the region. The overall (uninflated) programme capital expenditure (CAPEX) estimate was NZ$1.16B (Auckland Transport, 2014c), and the Stage 1 outturn cost was approximately NZ$215M (Auckland Transport, *pers. comm*., 24 January 2016). The Stage 1 OPEX is assessed within study 2 (Chapter 6).

Whilst other broader methodological matters have been discussed in Chapter 4, the choice of the AMETI as a single case within two of the detailed studies was deemed appropriate because the project:

- includes provisions for rail, bus, walking and cycling, freight and over-dimension (size/weight) vehicles, plus general traffic. The scope includes significant structures (including a tunnel), public transport facilities as well as transport networks, and significant environmental and cultural issues. It is therefore complex enough to enable a range of pan-organisational issues to be canvassed (i.e. that might not arise from a straight forward road widening); yet
- is deemed (by Auckland Transport) to be sufficiently representative of wider practice;

- is of sufficient magnitude (size and cost) to attract and/or demand proponents of best practice within both the study organisation and the wider New Zealand transportation sector; and
- enables extrapolation across multiple programme stages all of which are based on that of Stage 1.

APPENDIX VI: DETAILED STUDY 1 ANALYSIS

This Appendix presents a summary only. For brevity, once the overarching findings from this study emerged, the detailed analysis was reduced to supporting examples only.

AVI.1 Strategic interrelationships

Auckland Transport's key strategic documents ideally cascade out of the Auckland Plan (Appendix I). The actual interrelationships between key strategic documents were 'mapped' so that the connectivity (or otherwise) could be assessed (Figure AVI.1).

How to read 'subway map' Figure AVI.1

As a Council Controlled Organisation, Auckland Transport is required to give effect to the Auckland Plan (Section 5.1). The Plan sets out the vision for the Auckland region and a number of objectives (grey shading, Figure AVI.a). The transport objective (a well connected and accessible Auckland) is the primary focus for Auckland Transport, and is supported by four key transport-related directives (blue shading, Figure AVI.a) and a number of sub-directives, some of which are captured in Figure AVI.a (orange shading).

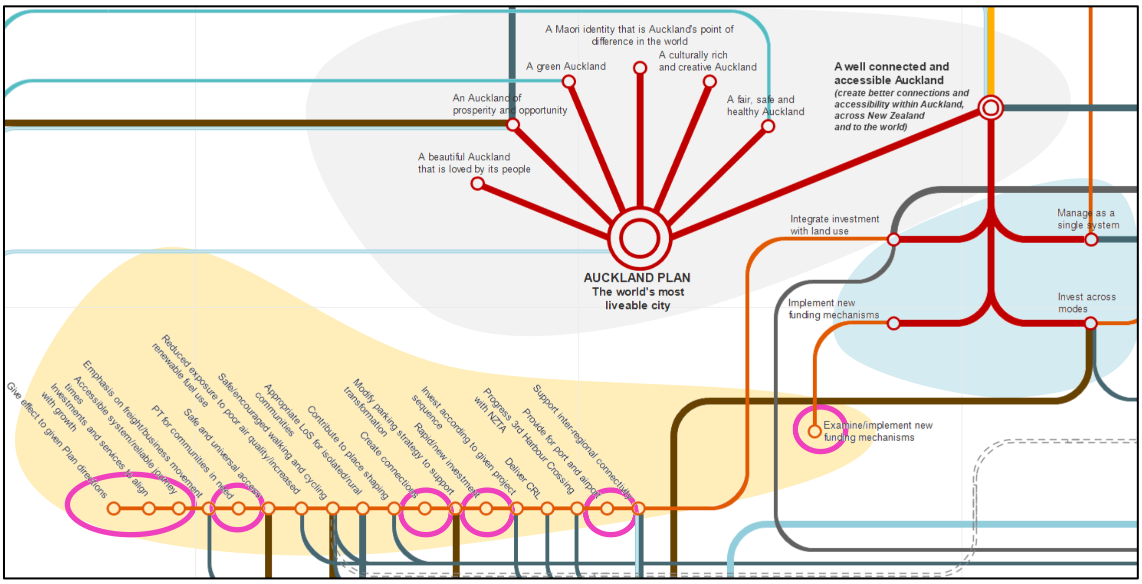
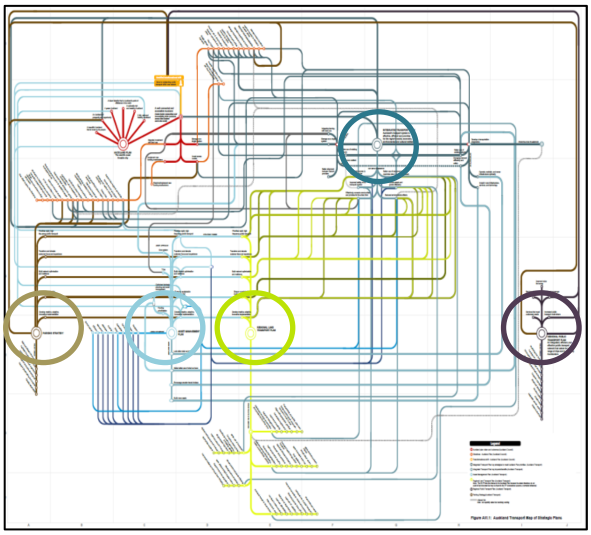


Figure AVI.a: Snippet from Figure AVI.1

Auckland Transport's primary strategic document is the Integrated Transport Programme, which is supported by a number of secondary plans establishing a hierarchy of strategic documents and the visions, objectives, and strategies therein (see Section 5.1 and Appendix I). These are not all visible in Figure AVI.a, but some of the connections between those documents and the Auckland Plan are shown (as coloured lines). These connections are presented as defined within the documents themselves. The Auckland Transport documents and their connections are colour coded as follows (not all are visible in Figure AVI.a; see the inset below):

'First-order' Auckland Transport strategic documents	Colour
Integrated Transport Programme	
'Second-order' Auckland Transport strategic documents	**Colour**
Asset Management Plan	
Regional Land Transport Plan	
Regional Public Transport Plan	
Parking Strategy	



Disconnects are shown by 'terminating stations', or points with no connection (for example the Auckland Plan sub-directives circled in pink; Figure AVI.a, preceding page). Inconsistencies in the Auckland Transport strategic documents can also be seen in Figure AVI.a within the area of orange shading. Those inconsistencies arise where second-order plans — in this case strategies set out within the Parking Strategy (brown lines) and the Asset Management Plan (pale blue lines) — connect to Auckland Plan sub-directives (bright orange nodes within the orange shading), but the 'higher-order' ITP (dark blue lines) do not (Figure AVI.a).

Further detail is set out within Section 5.2. Figure AVI.1 formed a framework for systematically analysing strategic connectivity (a summary of which follows below). The map shows the interplay between plans in a way that is more readily discernible than a simple spreadsheet as it is able to demonstrate the complexities of these interrelationships visually. Moreover, it enables disconnects to be highlighted which might otherwise have been hidden.

A grid has been included in Figure AVI.1 and is cross referenced throughout the following analysis to further guide the reader. Figures AVI.3 and AVI.4, which describe the interrelationship of performance indicators within the strategic documents, may be read in the same way.

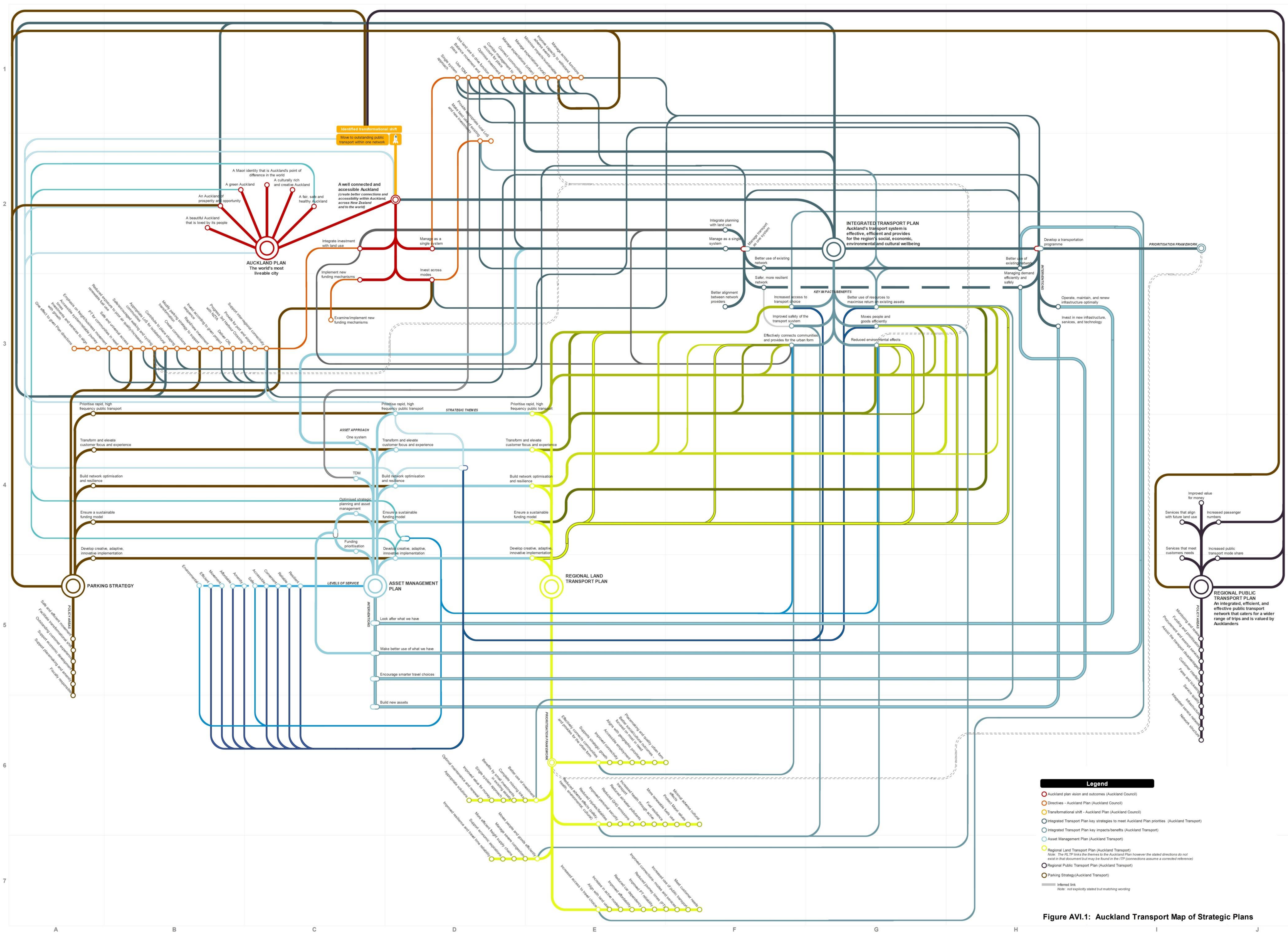


Figure AVI.1: Auckland Transport Map of Strategic Plans

Intentionally blank

AVI.1.1 Auckland Plan–ITP relationship

This Section describes and discusses the ‘Auckland Transport Map of Strategic Plans’ (Figure AVI.1). Grid references, linking to the figure have been provided to assist the reader. As noted above, only key points are described for brevity.

The Auckland Plan sets out Auckland Council’s vision and key objectives.[177] These are supported by key directives and ‘transformational shifts’. Whilst the Plan recognises Auckland Transport will contribute to several objectives, both Council and Auckland Transport have identified the most relevant objective for transport as “*create better connections and accessibility within Auckland, across New Zealand and to the world*” (Auckland Council, 2012a; Auckland Transport, 2013a).[178] This is supported by the transformational shift “*Move to outstanding public transport within one system*” (Ibid.).[179]

The ITP is the overarching strategic document for Auckland Transport.[180] It sets out the long-term (30 year) strategies through which Auckland Transport will give effect to the requirements of the Auckland Plan. Its aim (Auckland Transport, 2013a, p. 6):

> *Is to ensure that “Auckland’s transport system is effective, efficient and provides for the regions social, economic, environmental and cultural wellbeing”. In order to achieve this aim, six impact statements complemented by related levels of service* [...] *have been distilled from the* [Auckland Plan].

In broadening the transport objective, Auckland Transport has provided for other high-level linkages to the Auckland Plan.[181] However, the ITP itself is unclear as to

---

[177] Figure AVI.1; B2-D2.

[178] Figure AVI.1; D2.

[179] Figure AVI.1; C1-C2, D1-D2.

[180] Figure AVI.1; G2.

[181] Figure AVI.1; A1-A3, F1-F3.

how the Auckland Plan has been "*distilled*" to create the ITP's strategic framework. For example:

- Only some of the key directives sitting beneath Auckland Plan priority areas have been integrated within the ITP. But there is no indication why some were selected but not others, particularly when many of the omissions explicitly reference transport.[182]
- Other than establishing a direct link to the Auckland Plan's transport objective[183] and the clearly stated use of the 'One System' directives,[184] the ITP largely relies on duplicate wording to establish connectivity with the higher-order document.

The ITP has also identified six "*impacts*" (Figure AVI.2),[185] which it expects will occur from the Programme's implementation. It appears that these are designed to guide how high-level strategy is to be interpreted by the organisation as a whole. Whilst the establishment of outcomes is laudable, it is potentially unhelpful in this context because:

- five result areas have also been identified under ITP strategy one ('One System' approach);[186]
- three of the four stages of the intervention process[187] supporting ITP strategy two (transportation programme)[188] are also outcome focused, the fourth is output focused;

[182] Figure AVI.1; A1-A3, E1-E3.

[183] Figure AVI.1; D2.

[184] Figure AVI.1; D2 and D1-E1.

[185] See also Figure AVI.1; F3-G3.

[186] Figure AVI.1; F2.

[187] Figure AVI.1; H2-H3.

[188] Figure AVI.1; H2.

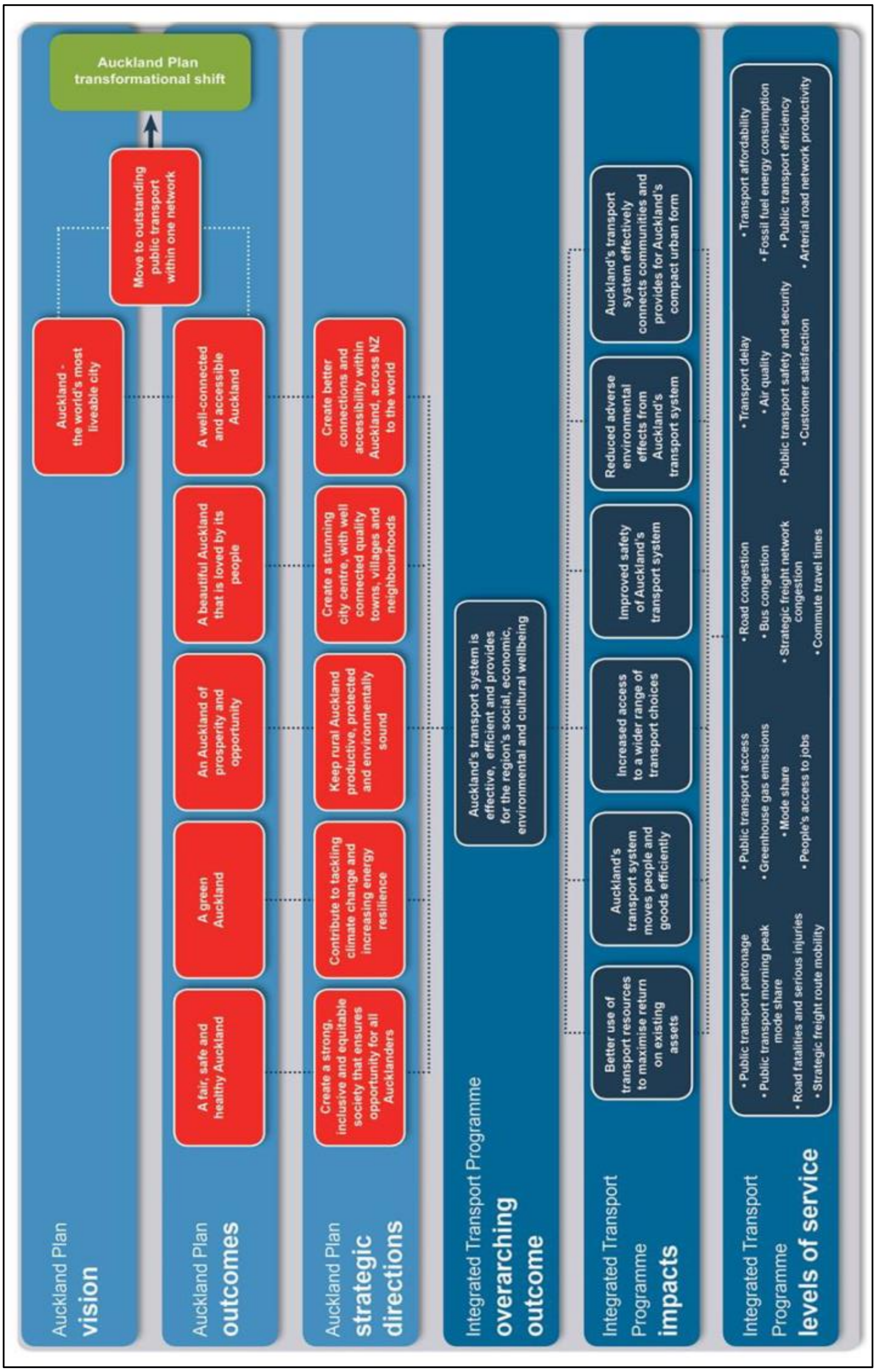


Figure AVI.2: ITP outcomes framework

Source: Auckland Transport (2013a)

- as a general rule, the impacts[189] have not been linked to:
  - the Auckland Plan.[190] It is understood from Auckland Transport that the six impact areas stem from discussions between Auckland Council, Auckland Transport, and the NZTA, and are the result of a process to workshop, then 'distil' the Plan;
  - Auckland Transport's own strategies.[191] So do not advance matters much beyond generalisations; and
  - second order/subordinate plans.[192] These generally map to the impact statements rather than the strategies. This obscures connections and could be problematic for feedback processes (including benefit reporting).

AVI.1.2 Second-order plans

This Section describes and discusses the 'Auckland Transport Map of Strategic Plans' (Figure AVI.1). Grid references, linking to the figure have been provided to assist the reader. As noted above, only key points are described for brevity.

The relationship between the ITP and its subordinate plans[193] exhibited similar issues to those just discussed. For example:

- The management of the transport system as a single system ('One System' approach) is one of two key ITP strategies.[194] Yet with the following exception, none of the subordinate plans link directly to this strategy.
- Whilst the RLTP prioritisation framework[195] does reference the 'One System',[196] the actual scoring criteria does not support this and covers only a small part of the eleven 'One System' principles specified by the ITP.

---

[189] Figure AVI.1; F3-G3.

[190] Figure AVI.1; C2.

[191] Figure AVI.1; F2-F3, H2-H3.

[192] Figure AVI.1; Parking Strategy (A5), AMP (C5), RLTP (E5), and RPTP (I5).

[193] Figure AVI.1; Parking Strategy (A5), AMP (C5), RLTP (E5), and RPTP (I5).

[194] Figure AVI.1; F2.

[195] Figure AVI.1; E4-E5.

- It was found that the 'One System' strategy,[197] like the remainder of the document, was largely disconnected from the wider strategic framework and it was unclear how the document and its strategies were to be given effect. This was underlined by the failure of the Parking Strategy[198] and the AMP[199] to reference the ITP directly at all, and there being only generalised references within the RPTP.[200]

Within the second-order plans themselves,[201] several other issues were identified (such as the introduction of new strategic themes).[202] Along with a similar lack of transparency and strategic connectivity, second-order plans also introduce other inconsistencies and conflicts. For example, the RLTP details a project prioritisation framework.[203] One of the stated criteria is that "*assets are renewed and maintained optimally*".[204] However, this is then excluded from further assessment on the basis that *"this is an asset management measure and does not relate directly to prioritising new CAPEX projects*" (Auckland Transport, 2015c). Both the inclusion of the given criteria and then its subsequent exclusion is curious because renewals are managed as CAPEX by the organisation (Chapter 6), and reportedly have a direct funding pathway.

It would appear, therefore, that there is a 'joining of the dots' somewhere within the system, it is just not transparent and accessible. This runs the risk that parts of the organisation will know, but these may not be all that need to know, and may get lost

---

[196] Figure AVI.1; F2.

[197] Figure AVI.1; F2.

[198] Figure AVI.1; A5.

[199] Figure AVI.1; C5.

[200] Figure AVI.1; I5.

[201] Figure AVI.1; Parking Strategy (A5), AMP (C5), RLTP (E5), and RPTP (I5).

[202] Figure AVI.1; Parking Strategy (A5), AMP (B4-D4, B6-D6), RLTP (D6-D7, F6-F7), and RPTP (I4-I6).

[203] Figure AVI.1; E6.

[204] Figure AVI.1; D6.

in time. It also makes feedback on the outcomes, and even a review of the prioritisation framework itself, problematic, and constrains feedback to performance measures; the 'do what you measure' conundrum (Senge, 2006).

AVI.1.3 Performance

This Section describes and discusses the 'Auckland Transport Map of Performance Indicators: Statement of Intent 2015/16-2018/19' (Figure AVI.3). Grid references, linking to the figure have been provided to assist the reader. As noted above, only key points are described for brevity.

The overview of both the strategic framework and board documentation highlighted the importance and complexity of organisational performance measures. Measures range from strategic indicators through to tactical levels of service, but the difference between these is not always immediately apparent (see Figure AVI.3).

The Auckland Plan[205] includes a list of measures through which Council intends to review progress against its vision and objectives (Auckland Council, 2012a). There are five core measures which map to the transport objective (see previous section; Auckland Council, 2012a).[206] A further five transport-related measures stem from the 'Liveability Measures' and the 'green Auckland' objective (Ibid.).[207]

The ITP[208] includes three separate tables which describe Auckland Transport's performance measures.[209] None of the tables fully align with each other and only some of the measures map to the Auckland Plan,[210] covering only some of the transport-related indicators.[211] Again, no attention is given to the outcome-oriented

[205] Figure AVI.3; B2.

[206] Figure AVI.3; D1-D2.

[207] Figure AVI.3; D2 and D1 respectively.

[208] Figure AVI.3; H2.

[209] Figure AVI.3; D1-E1, D3-E3.

[210] Figure AVI.3; B2.

[211] Figure AVI.3; D1-D2.

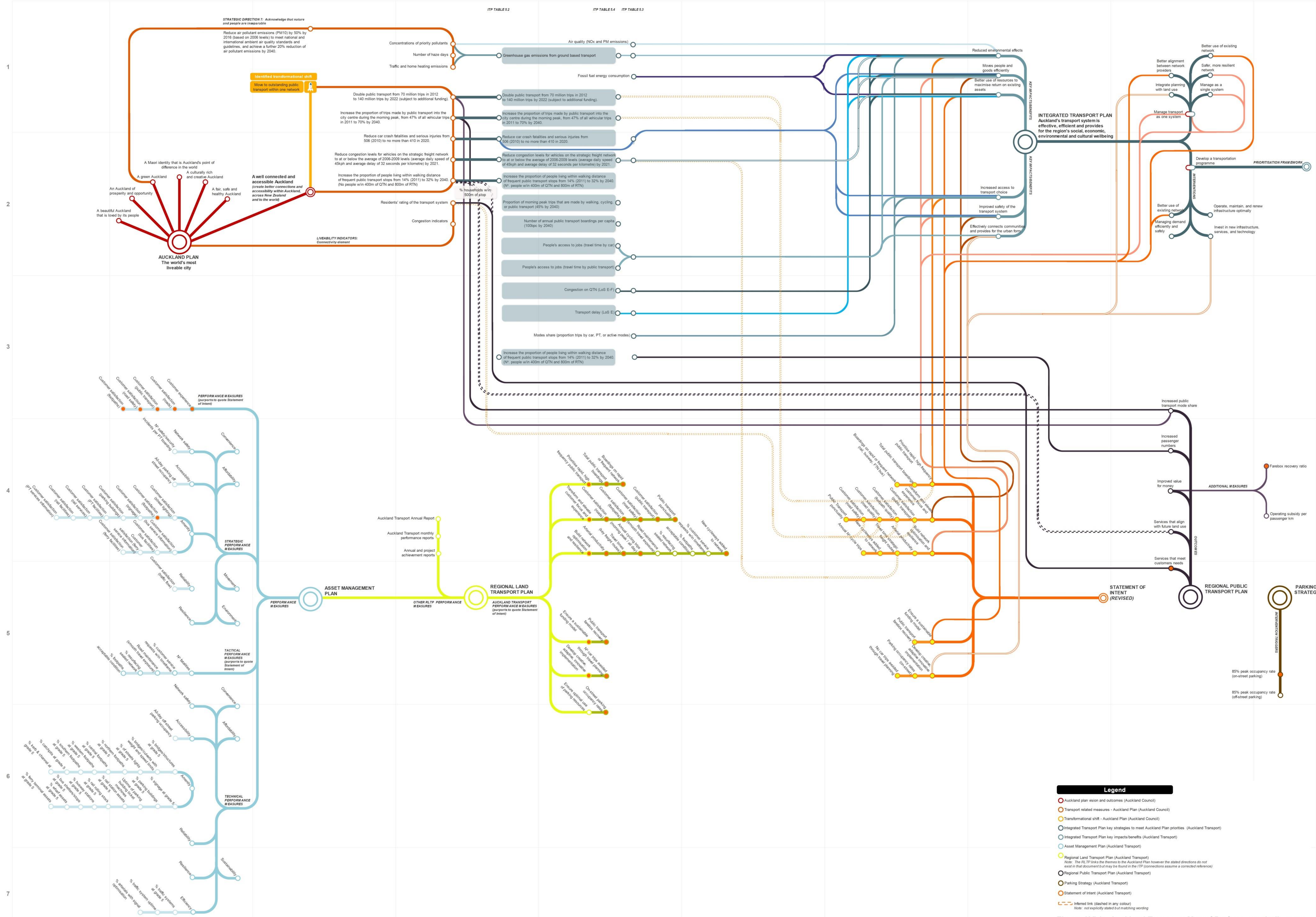


Figure AVI.3: Auckland Transport Map of Performance Indicators:
Statement of Intent 2015/16-2018/19

Intentionally blank

areas that support the two key strategies within the ITP.[212] In particular, it is unclear how the metrics support the strategy to manage the region's transportation as 'One System'.[213]

Similarly, none of the second-order plans[214] reference the measures within the ITP.[215] Instead the Parking Strategy,[216] AMP,[217] RLTP,[218] and the RPTP[219] all reference the SOI.[220] But few actually marry with the current SOI (Auckland Transport, 2014e),[221] and this appears to be an artefact of the SOI being refreshed annually.[222] The AMP does link its performance measures to parts of the Auckland Plan and ITP, and this assists legibility and transparency between these levels.[223]

---

[212] Figure AVI.3; I1-I2.

[213] Figure AVI.3; I1.

[214] Figure AVI.3; AMP (C5), RLTP (D5), RPTP (I5), Parking Strategy (J5).

[215] Figure AVI.3; H2.

[216] Figure AVI.3; J5.

[217] Figure AVI.3; C5.

[218] Figure AVI.3; D5.

[219] Figure AVI.3; I5.

[220] Figure AVI.3; H5.

[221] Represented by the orange infill within the measures: see AMP (A3-C3, A7-C7), RLTP (D4-F4, D6-F6), RPTP (I3-J3, I5-J5), Parking Strategy (J5).

[222] The current SOI measures (Figure AVI.3; G4-G5, H4-H5) do map to the six ITP impact areas (Figure AVI.3; H1-H2), and to some of the other result areas (missing from earlier iterations of the SOI). However, it largely does not map directly to the *measures* set out within the ITP (Figure AVI.3; D1-E1, D3-E3). Instead, a new tranche of measures is introduced (but not explained), which relate to improving customer outcomes (Figure AVI.3; G4 connecting to D2).

The SOI includes a table which sets out how the latest iteration of strategies will make a secondary contribution to wider Auckland Plan objectives. This is helpful as it establishes an explicit link. However, the change has not been reflected in the measures, nor have the 'threads' been followed through to the ITP or other documents for consistency.

[223] Provided in a table within the AMP, but not indicated by Figure AVI.3).

However, whilst it looks comprehensive, there are both inconsistencies, gaps, and disconnects. Many of the measures also rely on general satisfaction surveys which can be problematic (Chapter 7).

AVI.1.4 Changing strategic direction

This Section briefly comments on the 'Auckland Transport Map of Performance Indicators: Statement of Intent 2014-2017' (Figure AVI.4). Grid references, linking to the referenced figures have been provided to assist the reader. As noted above, only key points are described for brevity.

The refreshing of the SOI[224] provided an opportunity to consider the implications a change in strategy can have on a complex, strategic framework. A third 'strategic map' was therefore prepared (see Figure AVI.4). Comparison with the map of the latest SOI (Figure AVI.3; previous section) shows a change in explicit and inferred connections with both the Auckland Plan and the ITP,[225] and a change in alignment with second-order plans and measures.[226]

Even this simplest of comparisons highlights the need to provide for iteration of strategic documents and for the 'threads' of change to be followed through to their logical conclusion within the wider system. This is almost a necessity for a complex system, and continual iteration and adjustment of multiple parts is to be expected (Section 1.2). This need was recognised within the organisation, but at the same time, it was observed that there can be a tendency to 'write another strategy document' to address any perceived shortfalls. That, of course, simply adds to the complexity (and the challenge of aligning and iterating documents), and in enabling the system to adapt and evolve at the pace required.

---

[224] Located within H2, for both Figures AVI.3 and AVI.4.

[225] Located within B2 and H2 respectively, for both Figures AVI.3 and AVI.4.

[226] For both of Figures AVI.3 and AVI.4; AMP (A3-C3, A7-C7), RLTP (D4-F4, D6-F6), RPTP (I3-J3, I5-J5), Parking Strategy (J5).

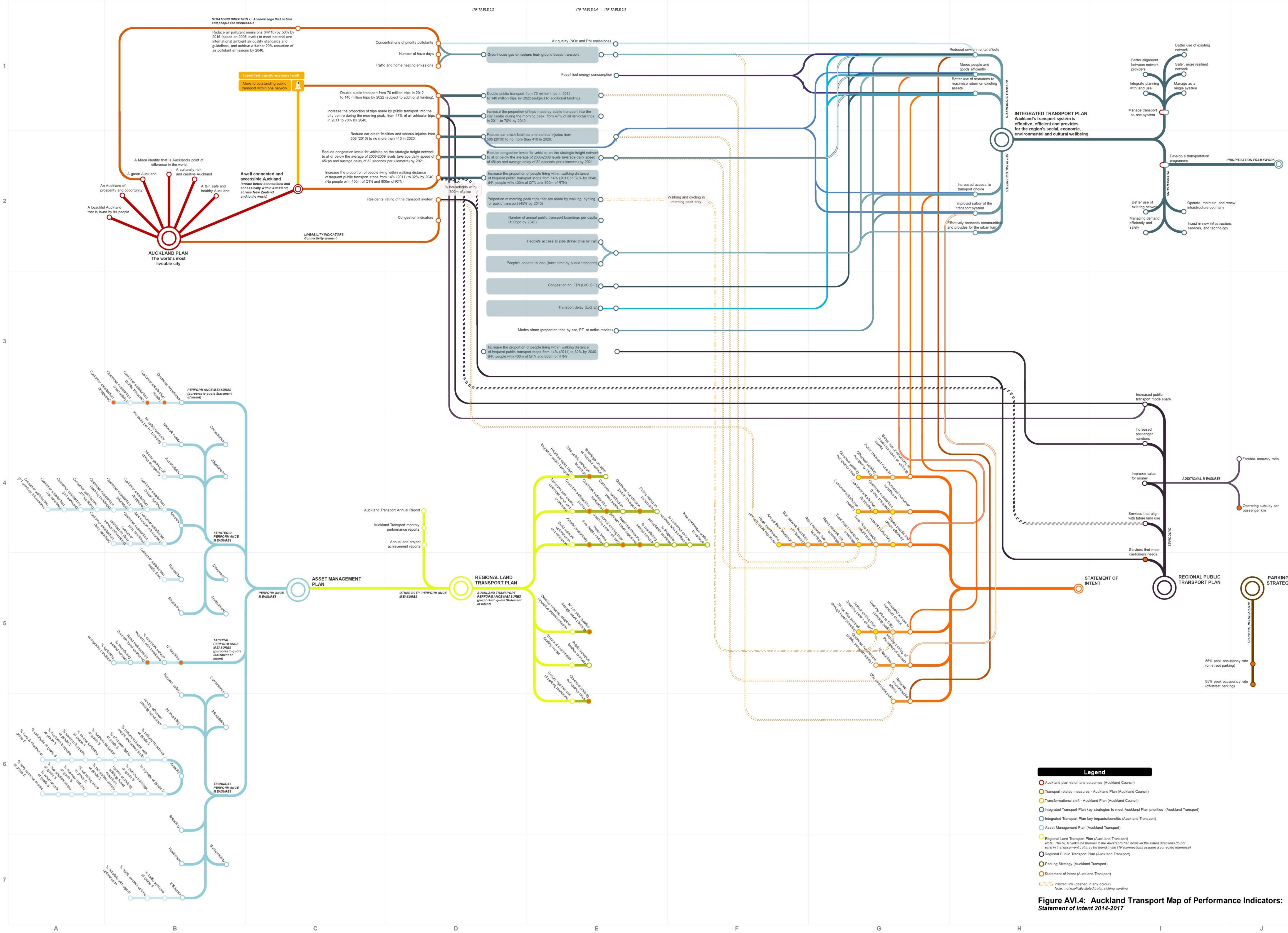


Figure AVI.4: Auckland Transport Map of Performance Indicators:
Statement of Intent 2014-2017

Intentionally blank

AVI.1.5 What is missing

Aside from any disconnects and omissions already mentioned, many general operational areas do not have much of a presence within strategic plans. This appears to include the Auckland Transport Operations Centre and functions such as:

- road corridor access;
- network maintenance;
- community transport (including TDM);
- property;
- communications; and
- business technology.

It is not clear how these parts of the organisation contribute to the delivery of organisational outcomes (how they fit, enhance, or could adversely affect these). Moreover, this touches on the matter of the clarity of accountabilities and so risks acts of both commission and omission (Ackoff, 1971), particularly when performance management is also considered.

It is also not clear why certain strategic directives from the Auckland Plan have been emphasised and others omitted. In particular, directives relating to rural areas and the balancing of place and movement are two areas that do not appear to be well connected within the various plans. Connectivity of strategies and the coupling with performance measures seems to be a factor in the visibility and follow-through (or cascade) of directives throughout the organisation.

There is also a temporal element missing here. This relates to the synchronisation of the various plans, the ability to review and adjust strategy (including the prioritisation framework and criteria), and mechanisms for capturing feedback at this level.[227] But the feedback needs to be firstly enabled. This cannot occur if there are disconnects and a lack of clarity in the strategic framework.

Finally, there is the opportunity to improve both the simplicity and clarity of the strategic framework. Of those spoken to, all observed that the framework was complex and that it was hard to understand how it all fitted together. However, this is not singular to Auckland Transport (Chapter 3).

AVI.2 Benefit visibility

This Section presents results from the analysis of Auckland Transport board documentation. Particular attention was given to the distinction between benefits and features, as well as the prevalence of benefit delivery (and feedback). The sub-sections that follow relate to the coding schedule set out within Section 5.2. Each are discussed in turn before turning to the other matters to emerge.

AVI.2.1 Benefits documentation

Overall, 'benefits' did not occupy much of the board documentation.[228] As already noted, this might not necessarily be a problem, as there is nothing to suggest that any given proportion is appropriate. But where benefits did receive coverage, this was often quite circumspect or repetitious. For example the 'alignment with strategy' section of the monthly patronage reports were the same for January–June 2015 [AT15b; AT15c; AT15d; AT15e; AT15f; AT15g]. Again, whilst repetition is not necessarily inappropriate, the point is that these contribute to the overall 'benefit

[227] None of the documents discussed how the measures would be used to feed back into processes or to adjust strategy. This passive collection of data — even when evaluated relative to success thresholds — does not in itself result in a change of behaviour, and/or evolution.

[228] In addition to the manifest content analysis (Section 6.2), NVivo was used to test and cross-check the dominance of benefits- and outcome-related terms. Board documents contained 1,000 frequently used words. The maximum weighted percentage was 1.31% (transport). The term 'benefits' does not appear until number 320 (AMETI occurs at position 318; 0.05%); confirming at the word-level, what was seen through coding, that benefits are not very visible at board level.

coverage'. Discussion of benefits accounted for less than 2% of all board documentation, and was often brief and generalised:

> *Various projects are underway that directly align to the improvement of Customer Services.* [AT12c]
>
> *Strategic Context: The EMU and EMU M&SF projects address the SoI target regarding "prioritising and optimising investment across transport modes".* [AT13b]

In the case of a project within a programme of works, the programme itself was often the sole justification for the project without review or reflection. Not only does this lack of detail inhibit benefit management and feedback, but, given the issues at the strategic framework level described previously, is a brittle approach.

Finally, the organisation persists in describing its achievements using features. Whilst this has its place, it does not further one's understanding of what has been achieved as "*transportation is not an end in itself*" (Auckland Transport, 2012a, p. 8). However, there were several good examples from community transport [AT13a; AT13d], the network optimisation programme [AT15h], the regional cycle programme [AT12i], and road corridor maintenance [AT11a]. These examples were notable for establishing the:

- drivers for change;
- benefits being sought;
- proposed features and actions; and
- outcomes that had been achieved (rather than the features delivered).

What was not apparent from the available documentation is how these individual areas/initiatives act upon each other and influence the benefits at the system level.

Notwithstanding the examples of good practice, the relative lack of benefit visibility at the board level is surprising. There was no sense of benefits being tracked or followed through. Consequently, there is no sense of where outcomes are either being delivered well, or being compromised. Rather, the overall emphasis is on the establishment of actions and the delivery of features on time and on budget. Given the lack of benefit visibility, this project management-oriented approach is redolent of the red queen: running frantically without moving forward (Carroll, 1954).

AVI.2.2 Infrastructure lifecycle/organisational structure

Strategy

Analysis of the board documentation shows that the issues identified with the strategic framework (previous section) are not new:

> *Some submitters were concerned at an apparent lack of alignment between the RLTP, the Auckland Plan and the* [Long Term Plan…] *funding allocations* [...] *do not reflect the transformational shifts and targets identified as priorities in the Auckland Plan.* [AT12g]
>
> *Overall, the SOI should be a statement which first and foremost aligns the Auckland Plan.* [AT12h]

Links between documents need to be explicit so that they are transparent, and clearly defined for the organisation as a whole. Otherwise, meaning could get lost in translation or manipulated to suit divisional objectives and drivers (e.g. Johnston & Pongatichat, 2008; Perrow, 1961).

Many strategic documents are dominated by programme/project lists, or actions driven out of performance measures as proxies for outcomes, and thence financial reporting (e.g. Auckland Transport, 2013a, 2015c). However, the documents do not cohesively work together and nor is there always a clear connection between strategic intent and the listed programme of works. For example, whilst the 2012 draft SOI set out a programme of action (which anticipated the ITP four step intervention process), it gave no basis for its prioritisation of works [AT12h]. For someone to understand the justification, they would have needed to await the issue of the ITP in 2013 (which advised a prioritisation framework was being developed), and later, the inclusion of the framework within the 2015 RLTP (by which time the 2012 SOI had been superseded). Issues with linking strategy/benefits and projects are also evident:

Auckland Transport should show how each item in the Programme of Action relates to the relevant Progress and Performance Measure. [AT11b]

Another aspect dominating strategic coverage was statutory- and compliance-related requirements, which often comprised only a brief summary of legislative drivers (and was often the sole strategic justification for a course of action). Otherwise, a significant proportion of statutory/compliance coverage was given over to consultation summaries and other related documentation. However, it was not clear that the requirement to consult was being sufficiently differentiated from the identification of community and customer need.

Operations

Operational material dominated board reporting and was itself dominated by the monthly reporting of public transport patronage data (see the performance and feedback section to follow). Issues associated with operational strategy and individual initiatives have been largely canvassed under strategy and projects respectively. The operational area was also responsible for some of the better examples of benefit assessment and reporting at board level (discussed earlier).

Capital development

Capital development material largely focused on the delivery of features, their cost, and the programme of works. At face value this is, perhaps, reasonable as project benefits/dis-benefits will have been subject to a high level of scrutiny through the business case, BCR assessment, and — typically — some form of statutory approval process. However, there is a sense that once approved, the project is treated as inherently beneficial.

Board-level project initiation processes appear to occur within either closed sessions or a separate sub-committee, as there was little in the way of related documentation available. Unfortunately, this does not assist in understanding or managing the benefits, and nor does it help process transparency, benefit evaluation and follow-up. This approach provides no indication of why these projects were needed, and what they are intended to achieve or by when, and what other parts of the organisation or the ‘One System’ they might affect. Furthermore — as discussed below — this ‘inherent goodness’ can misdirect.

Similarly, the aggregated board-level reporting of the BCR does not enable benefits to be managed or subsequently evaluated. Moreover, the BCR is an investment decision-making tool, and does not necessarily provide:

- For long-term operational requirements, or cover all benefits (which often relied upon an assumed frequency/level of service; Chapter 6).
- Any indication of whether the right benefits are being delivered, and what is being compromised (Damart & Roy, 2009).

This last point is particularly relevant to scope change decisions: simply reporting a change in the BCR gives no indication of whether the project will still deliver the outcomes that were either intended/required.

Overall, project initiation and other go/no go decision-making, together with scope change, received very little coverage within board documentation. Any discussion that did occur was not specific enough for long-term benefits to be understood, managed, or verified. This raises several significant questions:

- What is the basis being used to approve or vary projects (i.e. how do they connect to strategy/how are they being expected to transform the current system)?
- How are benefits then being articulated to projects?
- How can projects be held accountable for benefits and outcomes?
- What is the purpose and benefit of a stage-gate benefit realisation and management system in this context?
- What interventions delivered the expected benefits, what didn’t work, and what could be improved next time?
- If not the board, then who is responsible for closing the system-level strategic loop?

AVI.2.3 Performance and feedback

The 2012/2015 RLTP (Auckland Transport, 2012a, p. 44) advises project outcomes will be evaluated against a yet-to-be-developed ITP framework, which will reflect the applicable statutory instruments and provide a series of key performance indicators (KPIs), to "*measure changes in transport system performance as a result of the investment*". Crucially, whilst the ITP does include performance monitoring, it does not provide:

- monitoring and evaluation mechanisms for the performance of programmes and projects; and
- any system-level feedback and evaluation mechanisms (other than the reporting of data).

The effects of this could be seen within the way in which performance data was presented. Performance reporting comprises much of the board documentation, with monthly updates of regional metrics (such as road fatalities) and public transport patronage. Whilst this is not entirely inappropriate — for complex systems should, ultimately, be goal seeking (Ackoff, 1971) — as just noted, there are issues with the current approach from a benefits management perspective:

- Performance targets were initially missing from reported data. It wasn't until 2013 that either targets or forecasts started to appear [e.g. AT13f]. What is not clear is whether the actual patronage data, for example, is actively used to readjust those same forecasts.
- Performance reports frequently described reasons why targets may have been suppressed for any given month:
  - these descriptions do not appear to extend to 'lessons learned', changes in organisational processes, or interventions to address these issues. This potentially reduces the use of performance measures as a driver for behaviour change and outcomes. Whilst there was evidence that targets had been adjusted over time (e.g. thresholds had been attained), this is not a new issue and one the board itself has recognised:

    Patronage is the most important KPI for [public transport] *and* AT *is already behind on the SOI KPI target.*

    The Chairman noted this is not a new problem and simply restating the problem will not solve it [...] *More understanding about the root causes of this is needed and must be addressed* [in a paper]. *The paper* *needs to address not only what will be done but most importantly how actions will be undertaken and why it is believed they will work. He re-emphasised that* AT *needs to be a customer led organisation which will require a mindset change within the organisation.* [AT12j]

- with a single exception, patronage growing events or interventions such as the opening of a piece of major public transport infrastructure, the addition of a new ferry service, or the electrification of the rail network, do not appear to have been identified. Consequently, the success or otherwise of these initiatives and/or projects cannot be gauged over time. Yet understanding whether they have been delivered may be fundamental:

  Approximately 90% of the benefits arise from increased patronage, with most of the balance coming from a reduction in operating costs. [AT12b]

- Responsibility for KPIs, notably public transport patronage, does not appear to be shared across the organisation. In the public transport patronage example, there was no mention of how or whether other parts of the business such as road corridor maintenance or capital development were either assisting or impeding outcomes. Similarly, whilst Strategy reports regional metrics such road fatalities, it is not clear how the various parts of the organisation either have responsibility for, or are contributing to the broader organisational objectives. System-level outcomes may therefore be being compromised, opportunities missed, or data is simply being collated and reported.
- The analysis of the board documentation highlighted issues with the way in which performance data is being presented and then used to develop benefits. The focus was often on whether performance against the target has increased or decreased, and so is relatively passive; lessons or changes to organisational behaviour do not appear within the board documentation. For example, what can be learned from potential/new customers (i.e. those not targeted by satisfaction surveys), or from dis-satisfied customers:

  The customer satisfaction rating for [...] *car parks was 72%, an increase from the December 2012 rating of 68%.* [AT13e]

Other than general performance reporting, feedback comprises relatively little of the board documentation. Much of the general feedback relates to plan or network consultation (driven by statutory considerations), or financial performance. Examples of good practice do exist in parts of the organisation, as discussed already, and the ex post assessment of AMETI Stage 1 is discussed below.

In 2013, a project auditing framework was developed by the organisation [AT13h]. This included benefit realisation, and was aimed at major projects. Although the framework provided for interim and post-project audits, there were no audit results in the available board documentation. This is at odds with the aim of the framework to provide "*independent and objective assurance to the Chief Executive, the Finance and Risk Committee* [...] *and the Board that Auckland Transport's financial and operational controls are designed and implemented to manage risks and achieve Auckland Transport's objectives*" (Ibid.).

AVI.2.4 AMETI visibility at board level

Manifest content analysis (Sections 3.1, 5.2) showed AMETI was often mentioned but rarely in any detail. Once approved, projects gather momentum, and from the documentation, benefits are taken as a given. This can be problematic when the objectives or scope changes, and in the absence of feedback processes.

Treatment of TDM provided an example of inconsistency between board and project documentation (also see Chapter 6). For example, the project stated that TDM was integral to the design and the assumed baseline condition. By contrast the RLTP advised TDM was to be investigated, and whilst the community transport team noted the completion of some AMETI-related TDM activities, these did not align with project commitments.

The 2014 AMETI Stage 1 update [AT14d] reported that there was:

- 99% satisfaction with the Panmure Station;
- a 57% increase in passengers since opening; and
- an increase in bus/train transfers.

A further survey of those using the newly opened Panmure station found:

> *Almost all respondents are satisfied overall with the newly-upgraded stations, 97% at both Panmure and Mt Albert stations* [...] *Just less than a third of customers (32% for Panmure* [...]*) are very satisfied with the station overall* [... …]
>
> *The results are now being used by Operations staff to look at infrastructure improvements.*[229] [AT14a]

This is one of the few examples to show a cross-departmental linkage and purposeful feedback. However, the report did not indicate whether the feedback included those delivering the remainder of the AMETI programme (or, for that matter, other Auckland Transport projects). It also points to 'corrective' action being required on new infrastructure to meet operational need, and hence to additional expenditure (but gives no specific details of either). Again, it is not clear whether this has fed back into the wider organisation. Such expenditure is unlikely to be considered OPEX (Chapter 6), but the costs will still need to be 'absorbed'. This will either affect opportunities/levels of service in other areas, or the intended levels of service (and therefore the benefits) may not be realised for the project in question.

AVI.2.5 Other matters

Five secondary matters also emerged from this part of study (discussed in turn below).

Management of dis-benefits

Rarely, the board documentation would identify system constraints and/or possible project dis-benefits. What was not clear from any of the documents was whether:

- Such constraints:
  - are requested/identified as a matter of course;

[229] The survey report did not detail the improvements/actions.

  - are required to look beyond the immediate project or programme to the wider system and high-level objectives;
  - get communicated to the wider organisation (so, as a minimum, they are understood and not a surprise).
- Appropriate responses or strategies evolved to avoid, address, isolate or mitigate the dis-benefits to the wider organisation.

Customer need

Strategy development is currently dominated by the hard infrastructure typology, and did not appear to step back and ask fundamental questions around customer need. Whilst this is not the same as consultation on a proposed strategy, the consultation process does provide insights into how this might affect outcomes:

- The RLTP includes a project prioritisation process, with a given set of criteria, yet changes arising from the consultation process do not appear to be subject to evaluation:

  > *A number of submissions* [...] *were critical of the focus of transport expenditure on the city centre* [...] *Rural areas in particular perceived that they receive little benefit from expensive city centre projects, while the programme contains limited funding for rural priorities such as seal extensions, the provision of footpaths, and basic maintenance.*
  >
  > *Panel Recommendations:*
  >
  > - *Highlight region-wide benefits from major central city projects…*
  > - *Make specific allocation to rural areas for seal extensions* [AT12g]

  Whilst the choice might be appropriate, it cannot be determined why seal extensions were chosen from the list of issues, and whether this choice is appropriate to all rural communities and current needs (see Chapter 7).

- Consultation on the second generation of the RLTP [AT15a] included the following general feedback:

  > *It is apparent to the team that many of the people making submissions and/or attending Have Your Say Events are significantly misinformed*

about transport or have good information but still have a particular perspective and have expressed their particular view [...] *The following are examples of some of the things people believe:*[230]

- *Public transport is not subsidised at all* [...]
- *Fare evasion is widespread on the train network*[a]
- *The train network is dangerous to personal safety* [...]
- *That* [Auckland Transport (AT)] *has no idea what the community needs are around public transport*[b]
- *AT is a huge bloated bureaucracy that does nothing*[c] [...]

Points a–c were used to explore how this might affect the ability of the organisation to achieve its strategic objectives:

a) ***Fare evasion is widespread on the train network:*** Of the 765 coded board documents, the words ‘evade’, ‘evading’, and/or ‘evasion’ occurred in 73 (~10%) documents 181 times. In 2012, the board requested a “*vigorous campaign to deal with fare evasio*n” [AT12a]; the subject was addressed in most of the business reports and monthly public transport patronage reports for 2014. This might suggest the organisation is as concerned about the issue as its community (belief dimension).

For completeness, it is noted that a farebox recovery ratio is also currently a performance indicator within both the latest SOI and the RPTP (Auckland Transport, 2014e, 2015f). Whilst this indicator is aimed at factors such as increased patronage, commercial arrangements, operational efficiency, and fare subsidies, it is easy to understand how fare evasion could be viewed as being a part of this.

[230] In Chapter 3, the point was made that precepts (or belief) are one of the dimensions of an infrastructure problem. The others are needs, choices, and aptitudes. All four emerged from this analysis, and is the reason these examples have been included (i.e. it is the latent not the manifest content being considered here).

b) ***Auckland Transport has no idea what the community needs are around public transport***: It was only in 2013 that there was evidence that work on customer need had begun (giving attention to the dimensions of need and choice), and has since been an ongoing and emergent process:

This is the first time AT has undertaken a comprehensive review of customer attitudes and behaviour [...] *The research will help to develop a more detailed profile of people and cycling in Auckland, will guide promotions planning and provide useful information into* [...] *Community Transport.* [AT13c]

Similar work in the public transport area commenced at roughly the same time with the Customer Experience Programme [AT13; AT13g], and development of the new bus networks. The latter involved both preliminary consultation and an active approach to resolving submitter issues [AT12d; AT14c].

What was not clear from the available documentation was:

- whether customer need initiatives have since influenced strategy;
- how this information is now being used — not just by the one department with an interest in the given area — but right across the organisation;
- how this is being communicated externally; and
- how this evidence-base is being managed and refreshed over time.

c) ***Auckland Transport is a huge bloated bureaucracy that does nothing***: The board documents/organisational reports generated numerous actions and collate 'lots of data', but offer relatively little in the way of insight into organisational outcomes. This tendency to ***de***flect, rather than to ***re***flect upon the feedback and change (aptitude dimension) is perhaps a missed learning and (r)evolutionary opportunity for the organisation.

As the organisation has matured, it has placed greater emphasis on customer outcomes. Customer feedback, whilst required of local government in many circumstances, offers the organisation a valuable insight into customer need and perception, and so offers an opportunity to adjust itself rather than the customer so that long-term outcomes might be better achieved.

Dissemination and follow-through of initiatives

Several key initiatives were traced through the available reports with the aim of tracing organisational implications. Unfortunately, follow-up reporting rarely occurred; the notable exception being the corridor optimisation process discussed previously. In the absence of the opportunity to learn, adapt, and inform other parts of the organisation, any initiative becomes nothing more than an isolated action if it is not followed through.

It is unclear how the organisation, and its board, keep track of all the initiatives and then close the loop so that value can be extracted from these. In the least, there would appear to be merit in a register of initiatives, with reporting timeframes, and a requirement to present outcomes. However, this would only be a superficial response, and something more is required that enables the organisation to retain knowledge, use feedback, and to learn. Otherwise, the current approach simply reinforces the ‘red queen’-like culture.

‘Misdirecting’ outcomes

Some organisational services tend to report ‘practice performance’, rather than relate this to organisational outcomes:

> *Online campaign evaluation of the central corridors initiative saw a 44% prompted recognition; nearly half (44%) consider it innovative, 26% bold and 30% friendly.* [AT14b]

Whilst this is useful at one level, it can direct attention away from organisational goals. Even if unintended, the practice may give the impression that progress has been made, when this might not be the case. This makes it difficult to understand how outcomes are being changed or benefits effected.

Where reporting was outwardly focused, this was more helpful in describing the benefits that had been delivered:

> *86% thought the campaign/event was likely to encourage people to stay sober when driving* [...] *63% said the event got them more determined to arrange non-drinking driver.* [AT12d]

Inherent benefits

The documents also show an inclination to treat certain modes and initiatives as 'inherently beneficial':

- electrification of trains is good for the environment;
- any safety improvement project is beneficial; and
- walking and cycling, and anything that increases public transport must be beneficial for the transport system and the environment.

These statements may well hold true, but may not always be the case and obscures conflicts with other parts of the system. This was difficult to pinpoint because the assumed position is implicit, and where this arises, the documents remain superficial. This issue becomes apparent where there is no testing of the inherent benefit or 'goodness' of the proposal beyond budgetary constraints, which is often signalled by the cursory assessment of strategic context and project/programme drivers (discussed previously). Where a BCR is given, it is not unbundled, and so any wider benefits are not transparent. The issue is then further reinforced through the lack of consideration given to the wider implications of an action or initiative. This can be limiting when there may be a balance between movement and place, urban and rural, localised environmental effects and global targets.

State highway revocations

At the other end of the infrastructure lifecycle (albeit a new asset for Auckland Transport) are the State highway revocations [e.g. AT12e; AT12f], where OPEX was assessed/reported, but:

- Decisions did not appear to be subject to criteria consistent with that used by the organisation elsewhere (e.g. project selection and prioritisation).
- It was not clear whether the amount agreed with the NZTA for remedial work, or the estimated OPEX included any provision for integrating the new asset into the strategic framework or to otherwise bring the asset in line with Auckland Transport levels of service (not just for asset management, but across the organisation; Chapter 6).

Board documentation did not include material relating to the vesting of assets, so is an area for further research.

AVI.3 Project-level benefit management

The matter of benefit management within the AMETI project was touched upon as part of the cOPEX study (Chapter 6). Four broad themes emerged from a more detailed analysis of the benefit-related content of the available project documentation. Each is explored below, except for deferred benefits, which is discussed within Chapter 6.

AVI.3.1 How objectives and benefits are articulated over time

AMETI has been ‘in the pipeline’ for a significant period, so has been exposed to changes in strategic direction, including that arising from regional amalgamation. This change is not always easy to trace: some of the documents contained different versions of objectives, and it was not clear from the documentation whether (or how) the project reacted. Various design documents, for example, did note altered features between design stages, but these were not explicitly linked to strategic direction or other drivers.

Programme and project benefits have been captured in documents used to engage the Auckland community. These create another layer of expressed and, perhaps more importantly, expected benefits. This is reinforced by the Programme Initiation Document, which states that one of the project measures is organisational reputation (Auckland Transport, 2014c).

Existing tools and frameworks such as PRINCE2[231] (Turley, 2010) already emphasise the need for benefits to be articulated clearly, so this is a recognised issue. However, benefits are not merely a high-level list of objectives. Moreover, when viewed in concert with the earlier analysis (Sections AVI.1-AVI.2), this underlines the need for complete integration across the organisation, and for changes to instigate a systemic review so that the broader implications can be understood. Arguably, there is not always the time or the resources for this, and reality will often dictate the need to compromise. Either way, the rationale and implications of the decision need to be documented to inform future decision-makers.

Parsons (1995, p. 47) reminds us that Schön has already drawn attention to this gap between institutions and problems:

> *Institutions, he argued, have an 'inertial life of their own' and the problems of today all too often take place in institutional contexts that are fifty years and more out of date. Second, Schön argued that as change is so important a process to understand, the critical question to ask was how can we develop systems which best provide for learning and adaptation? There was, he maintained, not an 'information gap': there was no shortage of evidence, information and data. The deficit was less to do with information than our capacity for public and private learning. Schön focuses on the issue of learning rather than the idea of knowing: on the learning rather than the information or evidence gap and the gap between institutions and problems.*

This is where current benefit realisation approaches could misdirect with their emphasis on data warehousing (Sammon, Adam, & Carton, 2003).

In this vein, Auckland Transport also runs the risk of dragging ‘legacy contexts’ into the new organisation. Ultimately, as the context and/or benefits change, the organisation needs to be able to follow the ‘threads’ to their logical conclusion: back to strategy and out through the project delivery process.

[231] A process-based method for project management.

AVI.3.2 How benefits are managed through the design and delivery process

Benefits are intrinsic to the investment and funding process, and accordingly, the organisation's approach was to assign accountability for the management of benefits to the finance function of the project. However, it should not be assumed that benefits are expressed in the same way from the perspective of funding and organisational strategy: funding reflected NZTA requirements and appeared to be largely driven out of the traffic modelling, whereas project objectives were espoused in terms of a modal shift and multi-modal outcomes.

The addition of benefits to the conventional 'iron triangle' of project management, is now an intrinsic part of project management tools such as PRINCE2 (e.g. Turley, 2010), and is reinforced by the stage-gate tools such as Gateway (State Services Commission, 2010, 2013a, 2013b, 2013c, 2013d, 2013e). Although there was no formal benefit realisation process in place for Stage 1 of the AMETI programme, the project review process did include the scope and terms of reference to enable sufficient focus on outcomes and benefits. However, this did not transpire, at least as documented in the available material.[232]

As the project developed, there also did not appear to be any schedule of proposed outcomes and benefits, much less an understanding of how these were followed through. This was particularly important for the statutory documents, within which the wider strategic drivers and requirements are a key component. Within the design documentation, the main focus appeared to be upon the development and delivery of features. Any discussion on strategic context sometimes came later in a document, and often relied on generalised statements to 'broadly align' features with outcomes. This lack of documented follow-through became manifestly obvious when trying to schedule and then price the cOPEX (Chapter 6).

[232] It is not the place of this research to assess why this might be so.

AVI.3.3 How the benefit realisation process aligns with strategic intent and assessed benefits

Although AMETI has an established set of programme objectives, up until recently, there was no formal process for benefit management as a purposeful activity within the programme. Furthermore, whilst a benefit management framework did exist within the organisation, this was not widely known, less used (see above). Indeed, in Chapter 6 areas are pinpointed where the project's benefits had either not been delivered or were unlikely to be sustained in the absence of budgets and organisational exigencies.

The lack of a formal benefit management process was also noted by an audit of the second stage of the project (Controller and Auditor-General, 2015). Although a programme 'benefits realisation plan' has now been prepared (Auckland Transport, 2014a), the plan does not:

- identify the necessary baseline surveys and data needed to enable an *ex post* assessment of benefits to be completed;
- provide benchmarks, targets to enable outcomes to be assessed (this detail was to be 'further refined' and not available within the version of the Plan provided);
- follow up on the specific problems the project was expected to solve (some of these are set out within the Benefits Realisation Plan itself);
- revisit or otherwise utilise the benefits assessed within:
  - the BCR process;
  - statutory documents. These include benefits that have been expressed at multiple levels; from strategic goals through to technical/disciplinary outcomes, through to specific mitigation to avoid dis-benefits and negative outcomes;
- consider long-term, system-wide, operational requirements such as whole-of-life costs, or levels of service;

- establish a framework for the management of dis-benefits (plus any interface with risk management processes);[233]
- address community feedback and expectation;
- attempt to reconcile these with the overarching transformations being sought from the programme as a whole;
- state how the assessed benefits will feed back into:
  - subsequent project stages;
  - the operational system and definition of strategy;
  - consequential projects and programmes;
  - organisational processes such as the assessment and calculation of the BCR on future projects.

It would be easy to argue that the open wording of Gateway and benefit management processes provide for such matters to be addressed. This is true. However, matters such as salience, perception, the scope of existing processes and terms of reference can all influence what actually gets considered at the end of the day.

AVI.4 Influencing change

Figure AVI.5 shows the output from the 'influencing change' workshop (Section 5.2). Whilst very much organisation-specific, the broad themes are useful to reflect upon given the shared issues across New Zealand local government (Section 5.1) and even those expressed by the wider infrastructure industry (Chapter 3).

[233] Also, risk management will not necessarily cover this requirement as the project, in the New Zealand context at least, will be required to avoid, remedy, or mitigate significant adverse environmental effects.

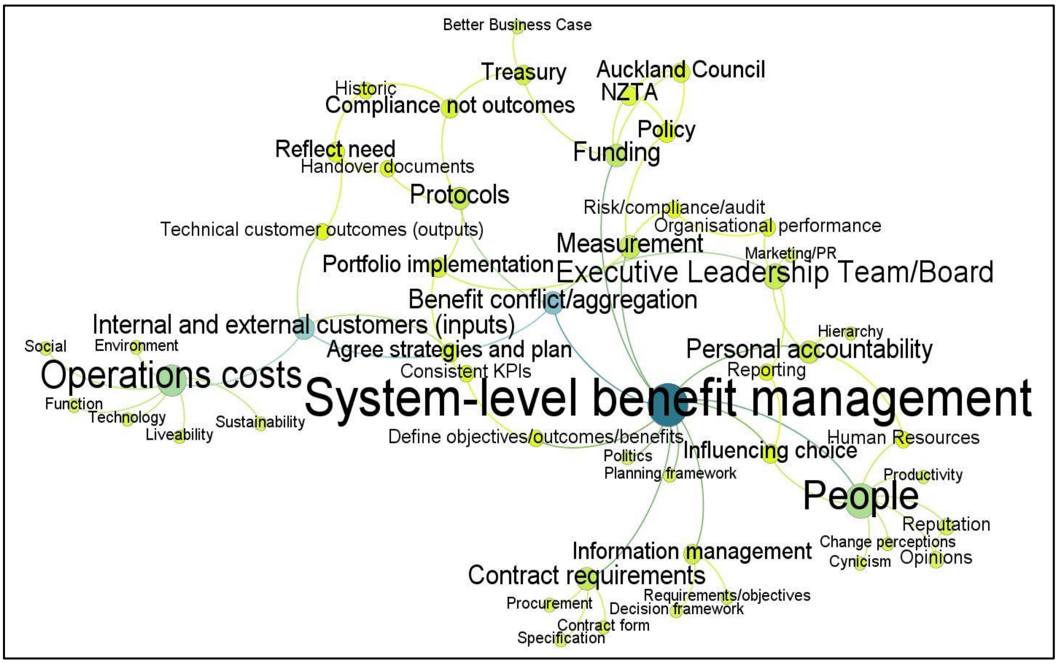


Figure AVI.5: Practitioner mapping of required change

Notes: Node and edge (connection) colouring denotes issue or factor communities. Text size indicates level of influence. These show the connectivity of issues/actions, establishing a hierarchy to assist the organisation prioritise its response.

APPENDIX VII: DETAILED STUDY 2 ANALYSIS

This Appendix presents a summary only. For brevity, once the overarching findings from this study emerged, the detailed analysis was reduced to supporting examples only.

AVII.1 Wider implications

As several sources augmented this detailed study with the aim of broadening the approach and the study's relevance (Section 6.2), this Appendix investigates the issues within their wider infrastructure context.

AVII.1.1 General processes

Information accessibility

Although AMETI Stage 1 was opened in 2014, it proved difficult to obtain the information necessary for this exercise. In particular:

- there was no clear bundle of information aimed at operational matters or handover. This had to be compiled, which took time and was incomplete. Missing information included, amongst other things, up-to-date as-built plans, management plans, and owner's manuals; and
- compliance requirements had to be retrieved from a consultant's archive, and did not show a complete document or decision trail.

Compounding this further is the practice of archiving of project files upon completion of the delivery stage and the lack of staff continuity within the organisation and its advisers between stages. Access to information is obviously necessary and important to inform future decisions. This becomes more so in the absence of a comprehensive or complete operational schedule and budgets, as these must be derived from first principles. This was the case here (see also Auckland Transport, 2015d), but is not a singular experience (Anguillid Consulting Engineers and Scientists Ltd, 2008, 2010, 2012). The advent of information systems has not necessarily helped either, as both AMETI and the above-referenced ‘legacy studies’ encountered issues with the coding and filing of information, document retrieval from data management systems, the completeness and accuracy/reliability of the archive, and staff creating separate filing systems as a work-around to these problems. Moreover, at this point, filing structures reflect project delivery requirements, which are unlikely to be suitable for the long term.

These are issues experienced by others:

> *It’s just reliant on people remembering that there was something in there* [...] *There is some institutional knowledge that gets lost* [PR26]
>
> *So now we have* [information technology (IT)] *we have the ability to have all of this so that it’s organisational dependent, not person dependent* [...] *but we actually document less detail on a better IT system. So the global effect is we pass less knowledge on and we cause more problems.* [PR37]

The Controller and Auditor-General (2010, p. 29), too, has also observed this:

> *There is no central storage of hard-copy information about Auckland Harbour Bridge. The information was held in various locations by several entities. Historical information was held by the NZTA library, the Auckland Harbour Bridge Library, Opus International Consultants Limited, and Archives New Zealand. Current documentary information on the Bridge is primarily held by the specialist structural engineering consultants.*

There is no current requirement to update business case (*ex ante*) whole-of-life cost assessments as a project progresses, or to produce a final assessment of cOPEX at project completion. Consequently, it is very difficult to know with any certainty that all project requirements and assets have been captured and integrated within operational schedules and processes. This has flow-on effects into asset management, compliance, and risk management (for example). It also affects knowledge transfer, learning, and adaptive capacity (Walshe, Harvey, Skelcher, & Jas, 2009), as other parts of the business may not know what they do not know, or need to know.

Issue salience and summing of the parts

Three key issues emerged around salience:[41]

- ***Project versus operational:*** The available documentation showed a tendency to prioritise project management and '*best for project*' delivery over operational, long-term, or system-level requirements or benefits. This was, perhaps due in part to document purpose (e.g. business case, consent application). Conventional project objectives (programme, delivery cost, and safety and environmental compliance during construction), also conceivably contributed to this.
- ***Functional focus versus systemic need:*** Organisational belief-systems can lead to the establishment of assumed accountability boundaries and a belief that excluded matters are either dealt with elsewhere within the organisation and/or not the responsibility of a given functional area (Chapter 3). The almost complete absence of any operational allowance for significant structures from the current schedule suggests this may be a contributing factor.[234]

  If the underlying question being asked of a local authority relates to an understanding of the consequential cost to the organisation and thence to ratepayers, then this must surely apply to the organisation as a whole, and without boundaries in the first instance. Of course not everything is able to be readily quantified (next point), but even the boundaries which define the CAPEX and OPEX, whilst arguably logical, nonetheless have 'fuzzy edges' and therefore, it cannot be assumed that everything will be automatically included. Two examples to arise within this study is the cost of accommodating the project works, and the cost of completing project actions after practical

[234] But as will be discussed later, investment assessment processes may have also contributed to the omission.

completion (e.g. reinternment of kōiwi.[235]).[236] Whilst these tasks might not be classified as cOPEX, these do need to be identified so that appropriate provision can be made and the boundaries of cOPEX better defined.

The handling of service costs is another example. The costs of public transport service improvements are managed separately, as these sit within another functional area. However, OPEX is, by definition, the cost to the organisation, so there is sense in reporting an all-encompassing OPEX figure before assigning accountabilities across the organisation. This should also improve transparency, performance feedback, and reduce the risk of omission or error.

- ***Familiar versus less defined:*** The 'estimated cOPEX' showed a bias towards assets conventionally found within the road asset management and maintenance (RAMM) database.[237] For example, road painting had been estimated to the nearest dollar for the individual types of marking (e.g. turning arrow, give way symbol, chevron). By contrast there was very little information on environmental mitigation or changes to public transport services. This is as much the ability to estimate costs that are perceived as tangible, as it is the comfort or sense of certainty that might be derived from standard systems, check lists, or previous schedules.[238] As Love, Lopez, Edwards, and Goh (2012, p. 102) note, familiarity may "*provoke error*" which "*proliferates through an organisation*". Several interviewees raised related issues:

  I'm not a big fan of the tick box because [...] *it moves from a tool to a decision-making proxy and* [...] *I've seen the same thing in* [RAMM] — *it's very good if you want information on the pavements but* [...] *not so good if you want to capture the community aspirations and have those*

---

[235] Human remains.

[236] Auckland Transport has advised that the resolution of the outstanding Stage 1 archaeological matters (which are not limited to the reinternment of kōiwi) is likely to take some time and could cost in the order of NZ$0.5M to resolve.

[237] Widely used within New Zealand local government.

[238] The 'do what you measure' conundrum (e.g. Senge (2006)).

> *change over time. It doesn't even record those so they get lost from the system* [... …] *I mean no one ever said that engineering tools took away engineering judgement.* [PR29]
>
> *I just see that it would be useful if the accounting system could actually assist good management by taking a wider definition on assets* [... …] *How can we have a negative depreciation?* [...] *How does the accounting norm allow for a more greening of the infrastructure approach?* [PR26]

Given these points, there is a risk, then, in using existing systems as the sole basis for determining cOPEX. Certainly maintenance and other operational schedules should be used to cross check, but this study has shown that requirements are greater than the sum of the conventional or technical parts. Furthermore, operational schedules and templates need to be revisited over time, and amended to reflect the specifics of any given project as it emerges into the wider system.

Compliance

Several compliance-related dimensions (and the environmental, social, and cultural matters to which this relates),[239] were found, and span the infrastructure lifecycle:

- integration of compliance-related matters within OPEX estimates;
- the purpose of project documentation;
- completion of project delivery requirements;
- third party interfaces; and
- consequential operational implications.

The first of these is discussed below and expands the discussion on omissions from the previous Section. The remaining points have been included in the relevant lifecycle sections that follow.

[239] Hereafter 'environment' encompassing all such matters —in line with s.2(1) RMA (1991).

Few environmental requirements were included within the 'estimated cOPEX' schedule.[240] However, this is not just a matter of whether the estimates are accurate and budgets appropriate. If requirements are not captured within the system, and budgets are a good indicator of this, then there is a real risk that requirements will not be implemented. Compliance is more than a performance target or measure, it is a legal obligation that has consequences for offences (including, but not limited to, financial ones).

This study highlights several process gaps for Auckland Transport. Firstly, operational personnel are not involved in reviewing or approving long-term conditions. Consequently, conditions were not only a surprise, they prompted a discussion as to how/whether these could be met. For example the operational plan for Van Damm's Lagoon[241] states the pond will achieve 34% stormwater treatment, whereas project conditions actually require 75% treatment to be achieved (ARC, 2003; Auckland Council, n.d.; Opus International Consultants Ltd, 2015). Whilst rectifying this shortfall might not be OPEX, it nonetheless remains a cost to the organisation, and, if not identified early enough, will emerge as an operational issue given enough time. In the meantime, because requirements have not been completed, the land attracts rates until such time the reserve status is able to be reinstated. As this will be 'absorbed', the cost and impact of the underlying issue are unlikely to be identifiable and 'known', curtailing the ability to change and to avoid repetition.

Secondly, the organisation needs the means of handing over, then managing long-term compliance (it is understood Auckland Transport is currently developing a database for this). However, as has been found on other projects, something more than this is required (Anguillid Consulting Engineers and Scientists Ltd, 2008, 2010).[242] For example, only some of the stipulated management plans had been

---

[240] Setting aside the all-encompassing requirement to maintain the asset in a good condition.

[241] A complex site that includes a dam, wastewater pipe bridge, and ecological considerations.

[242] Transferring requirements into a database is one thing, but it is the ability to embed or subsume a project into the *system* that is the key point here (proposition 1). See also the previous point about the limitations of management tools.

prepared, it was not known whether these had reached those with ongoing accountabilities, or even where within the organisation these had gone.

Compliance, like cOPEX, affects many parts of the organisation, and project-level requirements need to be congruently embedded at the 'system' level. Budgets need to be provided — not only for activities such as ongoing monitoring or the maintenance of environmental mitigation — but also to allow for the renewal of long-term consents and the consequences of adaptive management. Given the specificity of the conditions, it does not necessarily follow that all such costs are intangible as is sometimes believed. Furthermore, omitted actions can be difficult to resurrect, not least because this may be seen as introducing 'additional costs', simply by adding a new budgetary line item rather than making a relatively minor incremental change to an existing one. However, the implications of externalising effects upon the environment may not be 'felt' within the infrastructure organisation unless it is specifically set up to recognise these in the first place.

AVII.1.2 Project strategy and planning

Business case and funding

Auckland Transport completed an assessment of whole-of-life costs as part of the *Stage 1 Business Case for Construction* (Auckland Transport, 2013b). However, that estimate complies with the requirements of the NZTA cost estimation manual (NZTA, 2010), which defines 'whole-of-life' as the period from project investigation and reporting through to the end of construction.

Auckland Transport subsequently assessed the whole-of-life costs for the complete AMETI programme as part of its *Programme Initiation Document* (Auckland Transport, 2014c).[243] The document states that assessment was undertaken in general accordance with the requirements of the NZTA Economic Evaluation Manual (NZTA, 2013a), so is expressed as a net present value over a 40 year investment life, and uses the given NZTA discount rate of 6%. However, the purpose of an economic evaluation should not be conflated with that of estimating

[243] Post-dating the start of Stage 1 construction.

cOPEX, as different drivers and levels of detail may be required. Moreover, they are asking different 'questions'. In particular, the economic evaluation is specifically informing an investment decision and return on investment over a given period. This is very distinct from any question of operating expenditure over the long term:

- just because maintenance requirements fall outside of the 40 year assessment period at the end of the project/handover milestone does not mean that the costs do not exist or that it is valid to apply a static 'snapshot' assessment;
- maintenance requirements often increase over time as assets age; and
- budgets need to provide a rolling assessment and provision for maintenance over time.

However, any inclusion of maintenance in such an assessment appears to be an improvement on legacy practice (e.g. Maunsell/AECOM, 2007).

Notwithstanding all of the above, there is a question-mark regarding the level of attention subsequently paid to any business case, its assumptions and estimates, once a project has been approved, much less whether those assumptions are revised and available to operations personnel. This appears to be an issue on AMETI Stage 1, as no further assessment of the whole-of-life costs, beyond that just outlined, was included within the available documentation.

Several of those interviewed as part of the preliminary research also made related observations, pointing to this being a wider infrastructure problem:

> *I think* [organisation] *for example, is wading its way through a quagmire of latent infrastructure costs that haven't surfaced yet* […and] *yesterday I met with* [name] *from the Board of* [a second organisation…] *they don't have a very good fix on what the burden of costs will be on their infrastructure assets. The week before I was with some of the Board members of* [a third organisation] — *it's a very familiar story, it's quite amazing!* [PR42]

Flyvbjerg et al. (2002) made similar observations regarding project CAPEX estimates. Whilst Flyvbjerg et al. focus on the quality and 'honesty' of the estimating process, this study is highlighting its complexity. That complexity underlines the often overlooked necessity of identifying *all* needs *and* requirements as assessed from multiple perspectives.

A number of central government initiatives have recently been launched to improve the preparation of business cases and the effectiveness of public expenditure. These include the *Gateway Reviews* promulgated by the State Services Commission (2010, 2013a, 2013b, 2013c, 2013d, 2013e), and Treasury's *Better Business Cases* (e.g. The Treasury, 2015a; The Treasury, 2015b).[244] The *Better Business Case Framework* introduces operational expenditure as a risk to be assessed at the stage of developing the indicative business case (The Treasury, 2015a). Curiously, although the whole-of-life project or programme cost establishes a threshold above which the Gateway process is required or recommended, cOPEX is not specifically mentioned within the framework until *Review 4: Readiness for Service* (i.e. at completion of construction).[245]

There appears then, to be significant scope to bolster frameworks to not only improve the transparency of the whole-of-life costs used within project-related strategic decision-making, but to specifically provide for an operationally focused framework. Such a framework should be aimed at better informing strategic decision-making (after all, infrastructure strategy and governance is not limited to programme development and project delivery). The need for organisation- or system-level operational documentation is a common theme that arises in many of the issues discussed in this Section.

Project planning and approvals

Much of the available project-related design documentation had been clearly prepared and structured with subsequent statutory processes in mind. Whilst there is obviously a need for this, such documents, like those prepared for the business case and investment decision-making process, become the *de facto* project record.

[244] Both of which are based upon UK frameworks.

[245] There is earlier mention of managing operational risk, but no specific prompt to detail the whole-of-life or operational costs.

This does not necessarily result in operational matters being given due consideration, and the organisation being alerted to long-term implications or requirements. As was observed during industry interviews:

> *We always find that if the planning hasn't been done well, then the designers struggle, and* [...] *when it's all commissioned and the* [...] *owner of whatever you've created then turns around and says well you didn't take into account how you're going to maintain this or, this or that.* [PR27]

Other than providing for the 'maintenance and operation' of the new asset, long-term requirements were typically generic or focused on maintaining environmental mitigation measures. Whilst it is expected that consent documentation would broadly consider the whole-of-life implications, such documents (like the business case) are shaped and limited by the specific requirements of those processes. What this does highlight, is the need for a project to be specifically assessed and documented to inform operations. After all, a project is predicated on the basis of a system need and results in a change to that system, so it would surely be prudent to understand the implications of such a change.

Benefit management

cOPEX is also intrinsically entwined with the delivery of benefits, and particularly those that express themselves at the system level. Simply put, if intended benefits are not delivered, cOPEX might be lower, but is not actually 'reduced' *per se*. The corollary is additional benefits, additional features with no benefits, or benefits that do not align with strategic need or intent, can unduly increase cOPEX.

An example relates to the delivery of travel demand management (TDM), which was to have underpinned the design:

> *Once the residual traffic demand was estimated having accounted for the predicted impacts of* [public transport] *and TDM, the design of the infrastructure improvements commenced.* (Opus International Consultants Ltd, 2008)

The cost of TDM initiatives and additional public transport services were not included as part of the estimated cOPEX (or available for inclusion in the amended estimate). Yet these initiatives are a key underlying assumption supporting the effectiveness or the physical asset that was finally constructed.

Auckland Transport is not alone in this, for example:

> *Well I put it down* [...] *to incrementalism* [...] *no one's ever gone back to date* [...] *and asked those first principled questions* [...] *what outcomes do we want to achieve from this project? And does the solution we come up with actually deliver those outcomes, and if not, why not, and what should we do about it?* [PR18]
>
> [Benefit delivery is] *one of those things we're getting better at* […but] *if you really go and interrogate the system, mnnn, not quite so sure.* [PR47]

The matter of benefit realisation and management was the subject of study 1 (Chapter 5).

AVII.1.3 Project delivery

Design and construction procurement considerations

Ongoing operational requirements either received only cursory consideration within the available documentation or, alternatively, left operators guessing by referencing long lists of design standards and guidelines (but gave no clue as to which particular part of these was to be used). Such detail would better enable inspection and maintenance activities, and enable levels of service to be expressly articulated. Without this, the true cOPEX cannot be assessed, nor the implications of cuts to operational budgets fully understood. Issues with the management of product or supplier warranties complicated this further (but have not been included for brevity).

Yet despite such issues, there is a suggestion that New Zealand does relatively well overall *“maintaining a functioning transportation system at desired levels of service is part of the governmental ethic guiding planning and decisionmaking* [sic]” (Federal Highways Administration, 2005, p. 17). However, this does not cast light on whether operational levels of service bear any relationship to the design (or indeed, the strategic intent). In populating the cOPEX schedule, Auckland Transport identified cases where project levels of service did not align with current requirements and organisational standards.

Whilst the purpose of the study site visit was familiarisation, and not to audit the project in any way, it was apparent that there were areas where design choices will influence maintenance requirements. Inevitably, there will be the need to compromise and the balancing of competing demands or design requirements in any given project. However, maintenance requirements can obviously be assisted by purposeful consideration. Irrespective of the underlying reasons for eventual design decisions, the fact remains that if maintenance is to occur (to deliver the envisaged or specified benefits), appropriate budgets need to be identified. If the maintenance requires a scissor platform or rail closure, then this needs to be understood and appropriate budgets set aside. This would then enable feedback to strategic and design decision-making.

Industry interviews also gave rise to numerous examples arising from this part of the lifecycle. All this points to an issue that is distinct from the current literature focus on engineering and design error, which predominantly views error as a departure from process (e.g. Busby, 2001; Love et al., 2012; Reason, 1995). In this instance, a requirement to consider operational matters may not be explicit and even if it is, is not approached from the *operator’s* perspective (and there may be many of these within an infrastructure organisation), let alone that of the user or community it serves. Something more is required than generic considerations of durability and robustness: an understanding of the organisational capability and capacity to resource the operation of new technologies through to changes to contracts, systems, processes, and budgets (for example).

Questions also need to be asked (and answered) about how the organisation will prepare for the delivery of projects and, more particularly, the significant and complex transformational projects that may be multimodal or sensitive due to the social, environmental or reputational context. This is also likely to require different economic boundaries from those established for funding assessments, and may well drive a change to the time dependent (‘*use it or lose it’*) budgeting approach that currently challenges the ability for an enabling cOPEX budget to establish and foreshadow project completion.

Project completion

One of the questions raised through this exercise was: what happens to the expenditure required to complete project deliverables? Whilst the simple answer was that this is not OPEX and should reside within project budgets, this may not always be so clear cut for a number of reasons. How the organisation manages its internal budgets around project closure and handover boundaries is also likely to be a factor and may not be defined sufficiently for the transparent management of the CAPEX/OPEX transition. This in turn can affect the clarity of accountabilities and raises two questions:

- what actions or requirements get lost? And therefore:
- what costs get hidden as a consequence?

Examples where this was encountered (i.e. where expenditure is required after practical completion and completion of the ‘project phase’ within the organisation) included:

- resolving secondary project consequences;
- completing mitigation requirements;
- completion of other compliance requirements such as monitoring; and
- resolution of ‘defects’ (as defined from an organisational perspective).

One industry interviewee observing:

> *In an ideal world* [...] *we’d audit it before we were effectively handed over the keys. But often the case is* [...] *we’re given the keys and then we audit it* [...] *It’s not* [...] *that we’ve got a whole heap of engineers* [...]

> *who want to get their hands dirty, it's more* [...] *a case of being taken along the journey as it's being built* [...] *but also having a team that actually does check what* [...] *we originally asked for* [...] *and signing that off* [...] *So we've still got things that really, on a day-to-day basis for the operational side, are a problem* […and] *as projects wind up* [...] *nobody's really interested anymore* [...] *it becomes an issue for* [...] *us to pick up which is not really a great model of success either.* [PR53]

Deferred benefits

One final matter to arise around project completion is closely intertwined with benefit management, and relates to the alignment or reconciliation of statements made in project assessments with the finally delivered scope. This is the matter of the deferment of 'claimed' benefits.[246] The walking and cycling provisions of this project are an elegant illustration of this point.

The *Scheme Assessment Report* (Opus International Consultants Ltd, 2009) identified key transverse corridors, notably the link from Mt Wellington to the Panmure Town Centre and the Panmure Basin. The *Final Design Report* (B. I. L. Opus International Consultants Ltd, Brewer Davidson, PB, 2011) noting:

> *Each area of open space is isolated within its own context and there is little sense of connectivity between them. Pedestrian connectivity is restricted between the two most prominent areas of open space (Mount Wellington Domain and Panmure Basin)...*

The report proceeds to underline the significant enhancement to be delivered by the improvement of these connections (Figure AVII.1).

[246] This is distinct from agglomeration, being the "*spatial concentration of economic activity*" (New Zealand Productivity Commission, 2013).

Figure AVII.1: Panmure Station precinct

Source: B. I. L. Opus International Consultants Ltd, Brewer Davidson, PB (2011)

Figures AVII.2 and AVII.3 show the extent of the pre-project cycling and walking networks in the vicinity of the project. Whilst the cycle lanes delivered by the project will eventually contribute to the future cycle network, they currently finish at the edges of the project not at a destination. Similar examples can be found with the Pleasant View Road pedestrian and cycleway linkages (the alternative until the Panmure Roundabout is removed in Stage 2), and William Harvey Bridge connections.

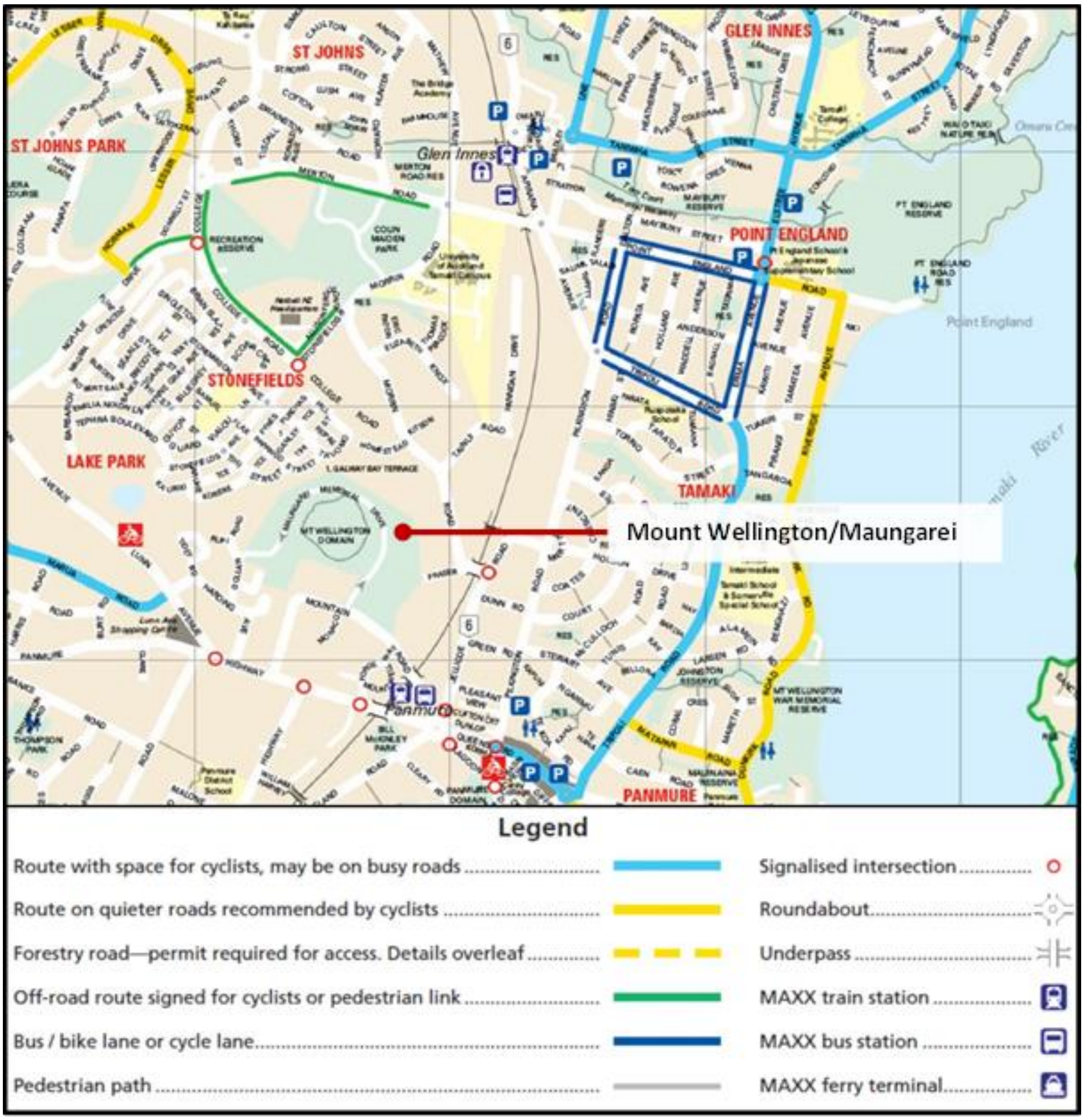


Figure AVII.2: Pre-project cycle network

Source: Modified from Auckland Transport (2011)

Figure AVII.3: Pre-project walking network

Source: Modified from Auckland City Council (2007)

The point is, whilst project boundaries are necessary, ‘connectivity’ requires a connection to something, least this result in the delivery of disjointed facilities such as the ‘around-the-block’ cycle lanes seen in Figure AVII.2. This was raised by study 3 survey respondents (Chapter 7):

> *Poorly designed infrastructure that takes you from a safe space into conflict with other users. The Star Trek effect where cyclists are expected to beam from one piece of infrastructure to the next when it got too hard to make it safe for the whole journey. No network approach.* [SR476]

There is an argument, then, for the project envelope to be variable by mode to enable appropriate outcomes to be achieved.

Deferred benefits were not recognised within project or organisational processes and have been left for the operations team to resolve. However, operational staff consider this to be CAPEX. Whilst the examples given here are relatively small, they relate to key outcomes and would now be difficult to prioritise given their size. Furthermore, the benefits have already been ‘claimed’. However, they would have been a very minor addition to the overall project. This underlines a need to ring-fence all consequential elements to ensure the outcomes upon which a project was predicated are actually delivered.

AVII.1.4 Operations

Handover processes

Whilst an internal project review showed Auckland Transport was aware of this matter (Auckland Transport, 2015d), one year after the project was opened, not all the operational management plans had been received or finalised. Many plans, such as those for electrical componentry, were generic lists, and did not necessarily assist operators in their day-to-day use.

As operations is accountable for delivering the levels of service and long-term outcomes on behalf of its community, it is incongruent that the handover process is either absent or so ineffectual that practical completion could be granted without the requisite handover requirements being satisfied. Indeed, this exercise reinforces a need to reorient infrastructure organisations away from project delivery and around, not just operations, but *operational outcomes*.

Similar issues were found in the Albany Lakes legacy project (Blom & Irwin, 2011; Blom et al., 2011), and Auckland Transport is clearly not alone. Although there is a paucity of academic material on the project handover and operational transition (except in computing/information technology), social media groups such as the ‘CAPEX to OPEX for Maintenance Reliability Professionals’ group on LinkedIn suggest a shared experience across several infrastructure sectors. Whilst this is part of the ‘knowledge transfer’ problem space, and is distinct from the difficulty organisations have in capturing project lessons learned (Busby, 1998; Flyvbjerg, Skamris Holm, et al., 2003; Schindler & Eppler, 2003), the inability to learn that there is a handover problem — and then to address it — is a compounding and confounding factor.

Whilst improving the project handover process is an obvious need, it is suggested that when viewed in the context of the other issues raised, poor handover outcomes are more likely a reflection or symptom of the wider systemic issues. After all, if cOPEX requirements had been appropriately costed, it should follow that there would be appropriate schedules, defined accountabilities, and an audit trail that leads to operational signoff for the delivered project. Improving the handover, whilst a key part of any way forward is not, therefore, a complete solution or 'simple fix'.

Maintenance specifications and requirements

An overview of an Auckland Transport standard network maintenance contract showed that although these are wide ranging, the contracts are largely focused on hard assets and need to be varied to incorporate specific features or more complex designs. This is not unusual (Anguillid Consulting Engineers and Scientists Ltd, 2010; Blom et al., 2011). Part of the issue is that there is an ongoing need to review and, if necessary, adapt standard specifications and documentation on a project-by-project basis. As projects are the means through which the organisation is proposing to transform the system, it is only prudent to review supporting processes accordingly. Without this, it is difficult to assess whether:

- the design and delivery of certain items could or should be standardised (e.g. limiting the breadth of architectural finishes or lighting choices);
- the introduction of a new asset or technology causes a system cascade in asset upgrades, or sets a precedent or expectation for the cost of future maintenance (cost 'ratcheting');
- efficiencies can be made (or conversely how to avoid replicating poorly performing assets or material decisions);
- the organisation has the capability or capacity to manage the emergent assets, systems, or services.

Furthermore, if the organisation finds itself managing reactively, it runs the risk of incurring additional costs through urgency and the reduced ability to plan and optimise.

Any review needs to be more than a superficial reflection on an evolving list of assets or services, as a range of secondary changes may emerge. In this instance, the site contamination and archaeological risks provide two examples where secondary consequences are likely (e.g. consents/authorisations, management plans, works hold points/delays, additional expenditure).

Without appropriate comprehensive and integrated frameworks in place there is a risk that, again, requirements, knowledge, and performance all dissipate, and operational costs might actually increase for the scope that remains. Preliminary research interviewees told of similar experiences:

> [The water treatment plant] *would have only have been put in because there was a government subsidy at that time, and I suspect they perceived themselves* [...] *that it was more than they needed* [...] *they perceived later on that they wanted to lower the running costs* [so] *they closed down part of the plant!* [PR31]
>
> *We understand* [...] *how* [...] *the system operates in terms of every morning there's a queue down here etc.* [...] *What* [...] *nobody really understands is why particular things were done. And it could be down to even the simple detail of why* [...] *a drainage pipe was put in that place and not that place.* [PR16]

The risk is that omissions, acting in concert with a myriad of incremental changes to scope, timing, and eventually costs, means that this becomes an insidious problem: difficult to quantify, and more so to diagnose.

AVII.1.5 Organisational interfaces

Organisational integration

Silos and decision boundaries affect not only the segregation of project and operational teams and their advisers, but organisational structures between the various functional accountabilities and disciplines. The effects of these factors can be seen within the amended cOPEX estimate, whereby a number of the line items fell outside of currently defined areas and were deemed a general ‘cost of doing business’. This introduces a lack of transparency, uncertain accountability, and appears to be where many of the tasks associated with compliance, social or environmental outcomes, mitigation, risk, adaptation and evolution reside. It is clear that both the cost and consequential actions arising from these areas may be difficult to define. But this does not abrogate the responsibility or requirement to actually manage and deliver these less tangible components, as these may not be as intangible as they are perceived (Section AVII.1.1). Moreover, given these are at the core of what defines infrastructure, this surely counteracts efforts to improve long-term performance and outcomes. Again, from the preliminary interviews:

> *Some of the* [facilities] *that were built* [...] *there was some* [...] *public amenity type things that weren't included. And then new people come in and go – well why? And the engineers go ‘oh well people might use it’. Well isn't that the point?* [PR61]

> *I think there's a number of problems. One is the client, and* [organisation] *falls into this trap* [...] *there's a project team working on that, and they're in their silo. Over here's another project and you know, same client but different siloed team and they don't talk to each other. They don't see what the big picture is.* [PR28]

There is also the need to prepare a single cOPEX estimate from a whole of system/whole of organisational perspective before assignations to organisational structure are made. It is clear from this exercise that cOPEX is more than the summing of the parts, and that there are not only ‘fuzzy’ boundaries between functions and stages, but many costs fall outside of existing tools, frameworks, or functions.

Third party interfaces

AMETI involves functional interfaces with other organisations including Auckland Council, KiwiRail, and the NZTA. In this regard, s.17A(5) of the LGA, 2002, requires that where functions are to be "*undertaken by a different entity from that responsible for governance*" that an appropriate contract or agreement is in place.

Without contemplating whether the SOI (Auckland Transport, 2012b, 2014d) fulfils any legal obligation, it was clear that at the project level, such matters had not yet been fully resolved. For example it is understood that at the time the data was collected, agreement had not yet been reached with Auckland Council over the ongoing management of Van Damm's Lagoon. This raises several issues:

- Whether Auckland Transport should transfer maintenance functions outside of the organisation. It has been suggested that it is appropriate for Auckland Transport to focus on road-related assets. However, this raises questions about what exactly a road asset actually is, and the place of 'blue-green' infrastructure (e.g. raingardens, swales, treatment ponds), or indeed overland flow paths, let alone more complex multipurpose infrastructure that might interface with transport. This is a perhaps an area for further discussion, particularly in light of the following two points.
- Operational costs need to be assessed early to enable the formation of an appropriate transfer agreement in the first instance, along with any funding provisions. It is understood that this is one of the details missing from the project's agreement in principle between the two organisations.
- This relates to the last of the compliance issues, and the separation of mitigation from effects. This is perhaps unique to the Auckland 'super city' and the establishment of Council Controlled Organisations where inter-organisational functions might assist efficient operations and/or introduce risk, notably:
  - Who is to hold the resource consent: Part of the organisation thought this might be transferred to Auckland Council stormwater (as that department would be responsible for maintenance and ongoing operations). However, Auckland Transport has no process through which they report on compliance and audit the performance of obligations carried out on its behalf.
  - The consent was issued for the discharge of stormwater from the road (effect) via the Van Damm's Lagoon (mitigation). There is a risk (exacerbated if the consent and/or operations were to be transferred to

Auckland Council stormwater) that the linkage between the effects and the mitigation are severed, and become non-compliant.

What is clear is that if responsibilities are to be transferred, Auckland Transport retains a duty of care to ensure that these are followed through over the long term and therefore to evaluate performance, as it would for any contract.

Programme staging

As part of this study, Auckland Transport was asked whether:

- it had undertaken an evaluation of the impacts arising from current plans to defer subsequent stages (particularly any impacts upon the benefits and outcomes of the first stage of the project); and
- given the timeframes, maintenance should be resumed or temporary improvements made.

It is understood that no such assessment had been undertaken.

AMETI has been likened to a series of smaller projects and accordingly, many of its benefits are agglomerated or reliant upon the delivery of other works and services. This highlights a need for an assessment of the impact on preceding stages (if subsequent works are to be significantly delayed or completely abandoned) so that the actions required to deliver the benefits of earlier investments can be understood and enabled.

APPENDIX VIII: DETAILED STUDY 3 METHODS AND ANALYSIS

This study comprised three stages:

- customer workshops (and survey piloting);
- national survey; and
- an investigation of influence and change.

To assist readership, this Appendix has been structured differently from the rest of the thesis by coupling the method for each stage with its results.

Note that this Appendix presents only a summary of the results.

AVIII.1 Customer workshops

AVIII.1.1 Workshop methods

Workshop logistics

Focus group locations were selected to reflect the NZTA's national organisational accountabilities. Locations were therefore sought in both the North and South Islands of New Zealand, and within rural and urban centres as follows:

- Napier;
- Christchurch; and
- Dunedin.

As Christchurch's infrastructure was still being redeveloped post-earthquake, there was the possibility that the discussion would centre on related issues; however, this did not transpire.

Time was spent considering who the NZTA's customers were, so that appropriate groups could be established. Given the aims of this stage, user or advocacy groups were targeted rather than trying to arrange a sample of random, yet representative individuals (so sample/workshop size is not an applicable consideration here). Whilst this arguably brings an inherent bias in the form of mode or user specific positions, this was considered appropriate in this instance for the following reasons:

- the purpose of the process was to elucidate the language specific to, and the needs of each mode and user group;
- the information was to be used to shape a more extensive appraisal of individual need in the form of the subsequent questionnaire.

Any bias was also tempered by the structuring of the focus group sessions, which facilitated a shared understanding across mode and user groups by starting with the higher-level concepts (discussed below).

A range of potential customer groups were identified and provided to the NZTA's Journey Managers who then sent out invitations based on local knowledge and availability. The invitations called for customer participants that were 'interested and available' on a voluntary basis. Potential customer groups included:

- car clubs (e.g. Automobile Association);
- advocacy for the elderly (e.g. Grey Power/Age Concern);
- disability advocacy (e.g. Be Accessible, Blind Foundation);
- cycling groups (e.g. SPOKES);
- universities/schools;
- those living beside roads and paths;
- other local interest groups (e.g. Marae).
- freight-related advocacy (e.g. Freight Association);
- bus-related advocacy (e.g. Bus and Coach Association);
- rural sector (e.g. Federated Farmers);
- children's advocates (e.g. Plunket);
- emergency Services;
- motorcyclists; and

A total of 28 adult customers participated across the country (12 in Napier, 10 in Christchurch, and six in Dunedin). This provided a diverse array of mode and user groups (Table AVIII.1).

Table AVIII.1: Summary of focus group participation

👤 = Mode or user group advocacy representation (does not indicate participant gender);
● = Mode use or user group from pilot questionnaire

Customer Group	Napier	Christchurch*	Dunedin
Freight	👤 👤 ●●●●	👤	-
Bus	●●●●●	-	●●
Emergency Services	👤 👤 👤	-	👤
Taxi	-	-	-
Car	👤 ●●●●●●●● ●●●●	👤 👤	👤 👤 ●●●●●●
Motorcyclist/moped	-	👤	●
Parents (pushchairs, children)	👤 ●●	-	-
Disabilities (e.g. mobility, sight-impaired, wheel chair user)	👤 ●	👤	👤 ●
Elderly (including mobility scooter users)	●	👤	-
Horse riders	-	-	-
Cyclists	👤 ●●●●●●●	👤 👤 👤	👤 👤 ●●
Pedestrians (including walking school bus)	👤 ●●●●●●●● ●●●	👤	●●●●●
Skateboarders/push scooters	●	-	-

Customer Group	**Napier**	**Christchurch***	**Dunedin**
Farm vehicles	-	-	-
Tourist/first time user	-	-	-
Residents interest group (customers living beside the asset)		-	-
Total Customer attendees	**12**	**10**	**6**

* *Questionnaire not piloted in Christchurch*

An NZTA staff member was sometimes nominated by a user group, or helped to make up numbers to represent an under represented customer group, particularly in the smaller centres. This was closely managed. No more than two NZTA staff participated in each of the customer sessions. In such instances, the staff were advised that they were there as a customer, and to avoid technical discussions or wearing an 'NZTA hat'. Where conversations drifted into such matters, these were addressed within the workshop and participants guided back to their role as a customer or user.

The workshops were facilitated by myself, and lasted a minimum of 2.5 hours. Additional time was spent at both Napier and Dunedin to pilot the first draft of the questionnaire, which was subsequently modified to reflect the issues raised in all three focus groups.

Exploring comfort

Few studies appear to have asked their customers what comfort means to them. So the first part of the focus group session started with the broad concept of comfort and explored what this meant to participants, canvassing the language used and the breadth of the factors identified. A series of cascading questions followed (Figure AVIII.1), which explored the concept of comfort as it related to transport generally and then to a range of land transport-based modes and user groups.

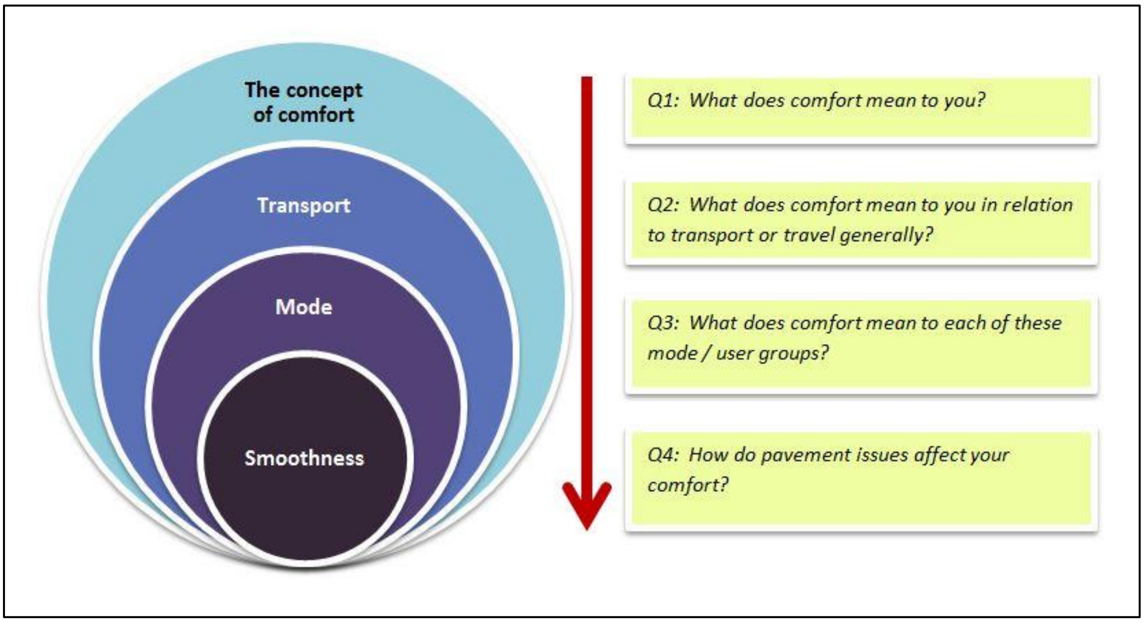


Figure AVIII.1: Exploring comfort

This essentially inverted conventional approaches to this topic and was subsequently found to be an effective means of enabling engagement, especially where modal or user tensions gave rise to competing needs. The different order of the questions, along with discussing the matter of comfort from a range of different angles enabled the possibility of triangulation both within each workshop and between the focus groups themselves (Eisenhardt, 1989). The approach recognises that the notion of comfort as it relates to road infrastructure may be a latent variable, which needs to be explored by obtaining the participants' sense of what it is or by exploring other attributes which together make up comfort (Eboli & Mazzulla, 2009; Parasuraman, Zeithaml, & Berry, 1985, 1994).

The first two focus group questions (Figure AVIII.1) were discussed in pairs to identify ***key words*** or ***factors***. These were written on cards so that these could then be pooled and grouped by all participants into key ***themes*** and those themes discussed. The themes were subsequently collated across all three of the focus groups by looking for common language and terminologies (termed ***notions of comfort***). To cross-check this synthesis, overarching word frequency analysis (irrespective of the underlying themes) showed that key words aligned with the majority of these 'notions'. Limited synonym clustering of less used terms gave full alignment.

Participants were invited to be more specific when defining comfort in transport and by mode. For example, 'safety' was a common, overarching theme, and as the focus narrowed, participants were asked to consider what safety factors affected comfort at each, more refined, level.

Prior to advancing to the third question (Figure AVIII.1), participants were asked to briefly share their understanding of what comprised the road corridor. This was to prime participants to subsequently focus down on road-related comfort issues and also provided a chance to reflect on how the customer understood any differences between highway and local road accountabilities.

The subsequent mode/user discussion again involved small group work. Participants were invited to view and add to the factors identified by other groups, before using the collective output to identify the most important factors affecting comfort for them (irrespective of mode).

Participants were also asked to comment on a range of technical footpath and road pavement defects shown in 160 photographs (Figure AVIII.2). The photographs were largely sourced from a preceding accompanied journey survey, but augmented to provide a balance of road- and footpath-related issues.

Figure AVIII.2: Example photos

Source: Anguillid Consulting Engineers and Scientists Ltd (2014)

Piloting the questionnaire

The final task was the piloting of the questionnaire (two workshops only). This involved:

- recording completion times, and discussing the number of questions/overall duration;
- answering questions and recording areas where clarification or changes were required (including changes arising from workshop discussions);
- seeking specific feedback on what was problematic, terminology, the scope of questions, and the range of factors given in the various questions.

AVIII.1.2 Workshop results

This section presents the proceedings of the workshop in response to each of the four key questions (Q1-4) set out within Figure AVIII.1 and the short aside (S1) to explore administrative boundaries.

Q1 The notion of comfort

Workshop participants were firstly asked to write key words, and then by grouping these, themes describing comfort as a general concept. Key words or synonyms sometimes appeared across themes. However, whilst noting the similarities, the participants made the point that their groupings/themes expressed different aspects of comfort as a general concept.

My subsequent analysis generated eight ‘notions of comfort’ from across the three focus groups (left-hand column, Table AVIII.2). For example, health, positive emotions, company, and food were uniformly grouped together by participants (synthesised to: ‘I have a sense of wellbeing and community’) and were grouped separately from the themes around relaxation and peace (‘I have peace of mind and am at ease’). To cross check this synthesis, overarching word frequency analysis (irrespective of the underlying themes) showed that key words aligned with the majority of the eight notions. Limited synonym clustering of less used terms gave full alignment.

Table AVIII.2: Notions of comfort

Notions of Comfort	**Key Words within Customer Generated Themes** *(selected examples from workshop)*
'I have freedom and choice'	▪ Choice (free to choose) ▪ Freedom ▪ Being able to do the things you want to do
'Life is hassle free'	▪ Convenience ▪ Easy
'I feel safe'	▪ Safe ▪ Security ▪ No fear
'I have confidence and certainty'	▪ Familiarity ▪ Confident ▪ Certainty ▪ Ability to respond to the situation
'I have a sense of wellbeing and community'	▪ Well-fed and watered ▪ Inclusive ▪ Friends, family ▪ Happy, contented
'I have a good personal environment'	▪ Soft/hard, warm/cold (depending on, say, back) ▪ No pain/discomfort ▪ Controlled noise/sounds ▪ Smells
'I have a sense of place'	▪ Visually appealing ▪ Surroundings (nice place, view, environment) ▪ Awareness ▪ Environment in
'I have peace of mind and am at ease'	▪ Relaxed ▪ Stress/anxiety free ▪ No pressure

Comfort and discomfort also emerged as distinct notions; comfort is "*more noticeable when it is absent*" [WP]. Pain was one example given by workshop participants. Pain can cause discomfort, but its absence does not result in comfort. Road smoothness was later identified as another such example: a poor road surface may make someone uncomfortable; however, a smooth road does not necessarily make a person comfortable.

The customers themselves observed that comfort was described both emotionally and physically, and that it had personal dimension or scale: "*Some people don't mind and are comfortable learning* [going outside their personal comfort zone] *whereas others want things under control*" [WP]. A range of other influencing factors were also identified such as whether a person was relaxed, stressed, safe, and physically comfortable or in a good environment, highlighting the interconnectedness of the eight comfort factors listed above. Comfort was associated with "*luxury and pampering, something special*" [WP]; a positive attribute, again distinguishing it from discomfort. Companionship was also identified as being particularly important: "*Even if you go to an unfamiliar place it helps to have someone with you. Shared experiences are important*" [WP].

Q2 Comfort in transportation generally

As requested, the factors (key words) identified for comfort in transportation became more detailed and specific than those expressed for comfort in general. For example the factors contributing to a customer defined theme around safety shifted from the generic '*safe'*, '*non-threatening environment*', and '*security*' (comfort generally) to '*condition of vehicle*', '*appropriate speeds*', and '*reduced roadside hazards*' (comfort in transportation generally). Of the themes that emerged from this exercise, knowledge and information, consistency and control, behaviour (road respect, manners and intimidation), safety, surfaces and overall design, and timeliness were identified as being particularly important.

Although there was overlapping of key words across customer-defined themes, analysis showed that these broadly aligned with the same eight high-level notions of comfort (Table AVIII.2). This provided a degree of verification by testing the emergent notions of comfort at a different scale (Heath & Cowley, 2004). However, the customers did identify an additional theme at this scale which related to cost and value. Further exploration of this aspect revealed that comfort was important, but that this was conditional on the cost to the customer.

One of the key messages to emerge from this exercise related to the aspects of timeliness, consistency and control; and demonstrates the importance of looking beneath terms that might be construed differently in a technical context. Customers in each of the focus groups made the point that most people at some stage in their lives will need to change modes, or become a pedestrian or mobility device user; whether as a child in a pram, or through ageing, illness, or accident. Consistency in the look and feel of roads and paths, and the ability to have control over one's life were seen as vital to comfort in this context. Timeliness was flagged not because of congestion delays, but because constraints, such as road works, might cause someone with a mobility or disability device to be house-bound and isolated for days or even weeks. Timeliness, consistency, and control were therefore interwoven with notions of self-expression, freedom, and community inclusion, all of which were seen by the customer groups as impacting on the comfort of those that were more vulnerable.

Where engineers are using comfort as a measure and are focusing on ride quality and physical comfort within the road carriageway, they may not be surprised that less tangible issues such as behaviour and timeliness (in the terms described by the customers) may be being omitted. Penn, in Knight and Ruddock (2008), discusses such a point in relation to the role of architects in the built environment and building design in particular. He talks of retailers creating a 'customer experience' or designers that identify with an 'innovative environment'. Notions that Penn argues are "*indefinable except as judgements of a building in retrospect*". Whilst a brief or specification cannot define such intangible outcomes, Penn is of the view that this is what distinguishes architecture as a profession, and why intuition, judgement, and tacit skills learnt within practice are so important. It is argued that engineering is no different. Indeed, an approach that embeds such intangible elements within technical practice is necessary if customer-centric strategies, such as those of the NZTA, are to be meaningfully delivered.

S1 Organisational/administrative boundaries

When it comes to the road corridor, customers emphatically noted that they weren't aware of, or particularly interested in the differences in accountability between agencies. Viewed as a single entity comprising roads and footpaths, it was seen as a network that helped customers connect with where they wanted to go [WP]: "it is *not a railway to get things from A to B*", "*corridor is a commercial term and not about the quality of life*"; "*network gives you choic*e".

An example was cited of two nearby townships which previously had good connectivity. But with the highway, they were seen as now being quite isolated "*unless you have a car"* (high speed, narrow, no paths, and facilities all located in one of the towns; [WP]). In their view, the towns were further apart now than they had been 100 years ago. A change, they felt, that had occurred dramatically in the last few decades: "*New Zealand roads have not kept up and also need to consider all users more"* [WP]. Footpaths too, in their minds, had not evolved to cope with, say, mobility scooters or to enable parents to walk side by side with pushchairs without impeding other users. Similarly, road "*radii are designed for vehicles* [...] *vehicles turn faster —this can be an issue for* [...] *people trying to cross at intersections"* [WP].

All groups also highlighted the effect on comfort of the different standards between highways and local roads, and across local authority or funding boundaries; all of the groups identifying the example of road edge and pull-off areas to explain their point. They observed that seal frequently does not extend far beyond fog lines (painted edge; see Figure 7.1) and is often accompanied by a large level difference even with a sealed shoulder. They saw this as a funding boundary (pavement width) and maintenance or contract boundary (transition between surfaces).

The issues this raised for customers were numerous and ranged from an inability to pull off, reduced manoeuvrability (trucks) and effective lane width (cyclists), risk of overturning, risk of tripping, and the risk of getting stuck or breaking mobility devices. Customers commented that they were uncomfortable with the uncertainty that these factors caused; highlighting a difference between technical acceptance and perceived user comfort.

More specifically, whilst high shoulders with a specified level of rutting would be defined as 'ineffective' from a technical perspective (Transfund New Zealand, 1997; see Figure AVIII.3), the very issue identified by the customer focus groups is expressly identified within NZTA technical guidance as being 'adequate' (Transfund New Zealand, 1997; see Figure AVIII.4). This would suggest not only the need to consider a measure for footpaths and road cross-sectional profiles (particularly at crossing points and intersections), but also the need to review technical specifications, and embedded processes and procedures to align with strategic objectives.

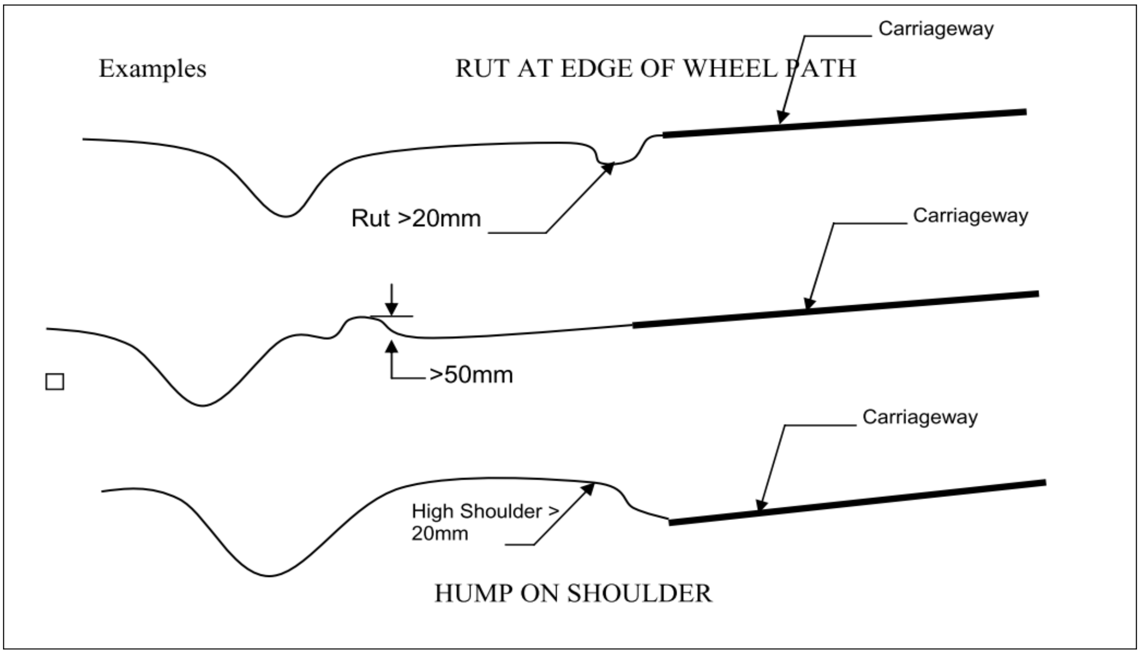


Figure AVIII.3: Examples of ineffective and technically inadequate road shoulders

Source: Transfund New Zealand (1997)

Customers noted that a holistic approach was required; a solution for one mode can cause problems for another. Citing rumble strips which push trucks out from the edge, they observed this reduces traffic separation but creates space for cyclists (see also G. Johnson, n.d.). Similarly, exposed aggregate footpaths might assist with grip, but break canes used by the sight-impaired.

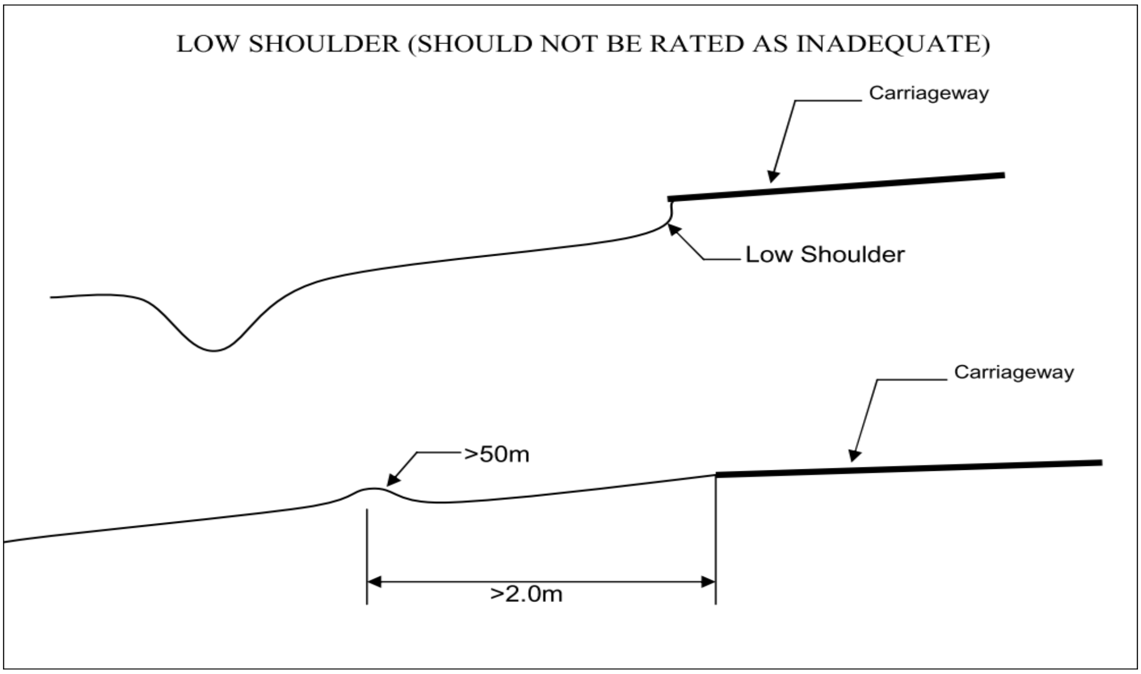


Figure AVIII.4: Examples of technically adequate road shoulders

Source: Transfund New Zealand (1997)

In customers' minds then, transportation comfort was not just limited to the interaction with the physical asset or means of travel. Customers instead expressed a need for a holistic, system view to be adopted, as comfort on the asset itself was a subset of comfort in their wider lives.

Q3 Transportation mode specific comfort

Although most participants drove cars, the results of this stage indicate a collective customer view across the focus groups that the mode/user groups with the widest range of issues are those using mobility devices, followed by cyclists (Figure AVIII.5). The most frequently identified issue across all the modes was consideration of or by others, followed by road and path surface issues, and road design generally (Figure AVIII.6). This reinforces the point made earlier that customers view comfort holistically across all their mode choices. They noted that designs for vulnerable users would encompass their needs as a car user, but not the other way around.

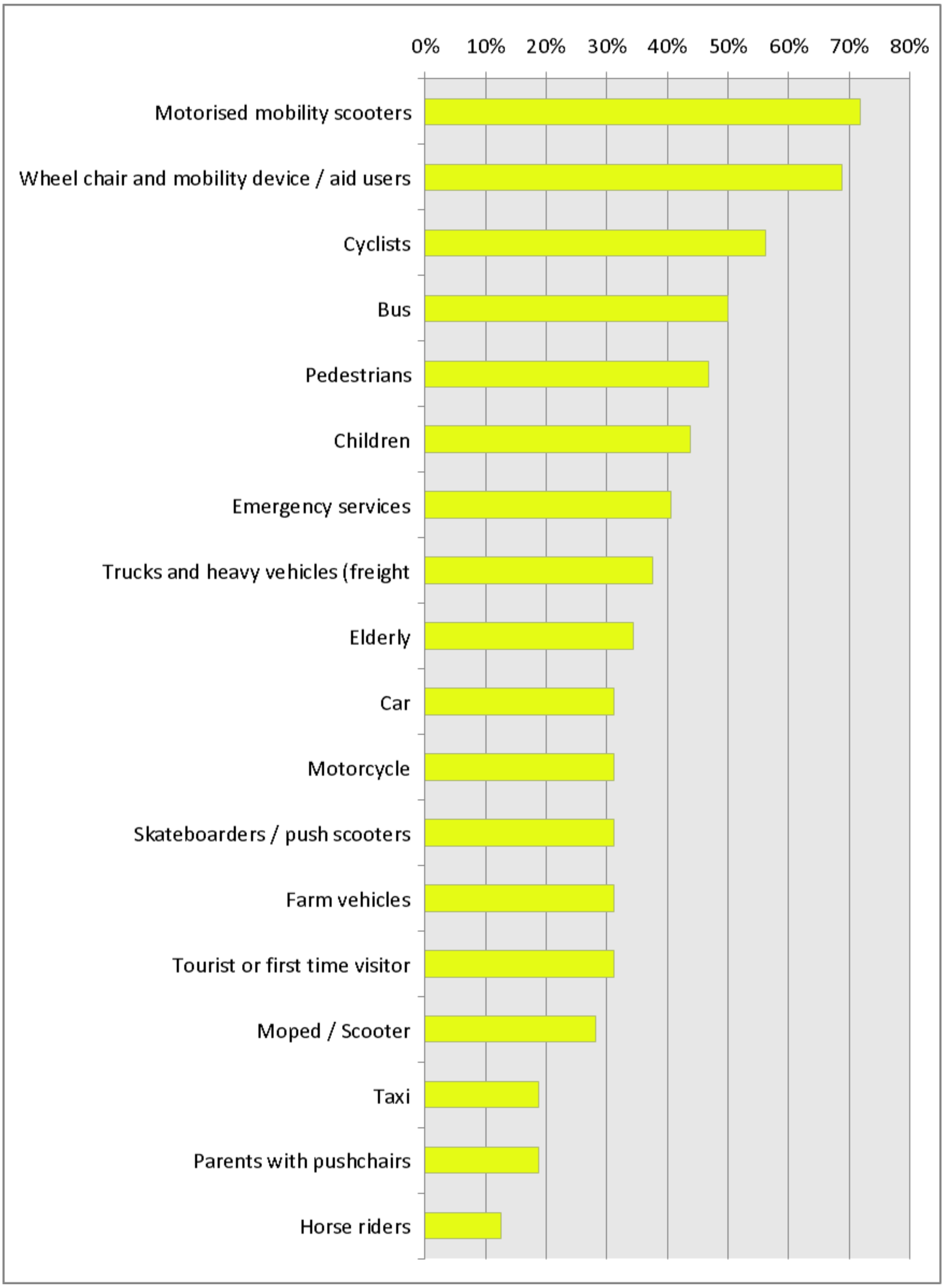


Figure AVIII.5: Dominance of comfort factors for each mode or user group

Percentage of the Comfort Factors (as listed in Figure AVIII.6) that were identified as relevant to each mode)

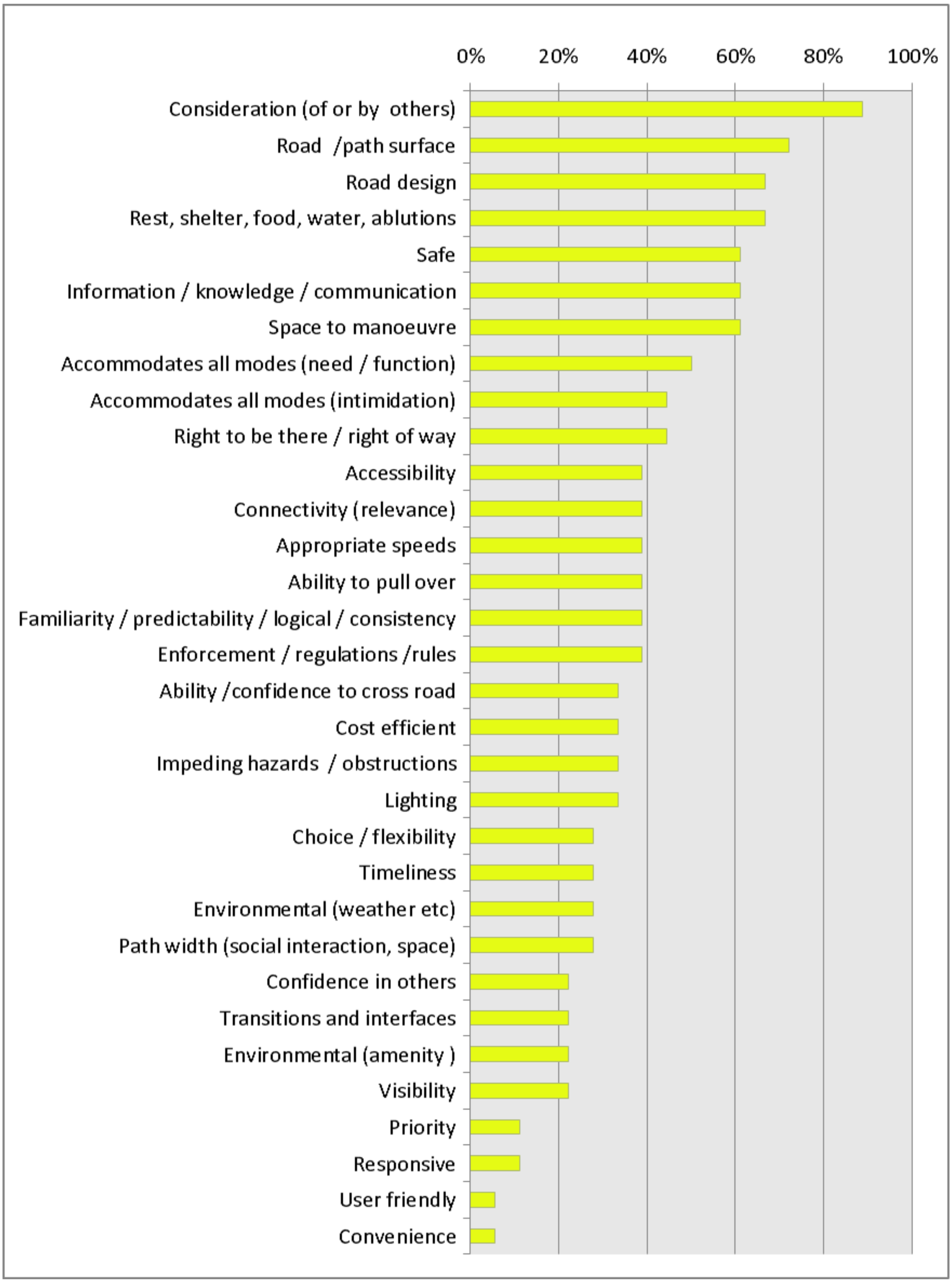


Figure AVIII.6: Frequency of comfort factors across all modes

Percentage of the listed Comfort Factors that were identified as relevant to all modes (as listed in Figure AVIII.5). Note: The comfort factors that were generated have been grouped into core themes.

Customers were then asked to identify which of all the mode-specific comfort statements/factors were most important to their overall comfort irrespective of the mode or user group for which they were generated. The factors the customer groups saw as critical to comfort are ranked in Figure AVIII.7.[247] This indicates that whilst road smoothness is both a frequent and a critical concern, the customers were most concerned with a wider range of issues that relate to vulnerable users in the first instance. To address these concerns, pavement smoothness would need to be measured in a way that addressed all user needs, and a range of other comfort indicators may need to be considered.

Q4 Pavement specific issues

Finally, participants were asked to comment on the comfort effects of a range of technical footpath and road pavement defects. Participants were asked to 'tag' or prioritise these as either intolerable or of high importance, and to briefly note the issue of concern and which mode it affected. Issues and modes were not defined so that participants had a free rein, and notably, this did not constrain customers to matters of pavement smoothness. However, participants were asked to focus on issues that related to comfort.

68% of photos were tagged and of these, 65% were tagged by more than one focus group, and 28% by all focus groups. A range of issues were often identified in each photo. Using a presence/absence indicator, more photos contained an issue for cyclists and pedestrians than any other mode or user group. Frequency analysis of the total number of identified issues was again dominated by those issues specific to cyclists and pedestrians. This was despite the wide range of customer interests represented and the majority of participants using or having access to cars. The key issues are shown in Figures AVIII.8 and AVIII.9 (overleaf).

[247] Figure AVIII.7 relates to Figure AVIII.6, but because the underlying detail is important to this point, the individual factors have been used (i.e. Figure AVIII.6 is a summary).

Comfort Factor	Critical to comfort
Accommodation of all modes (needs/function)	
Texture of roads and footpaths (good surface, debris, consistency, bumps)	
Space: to manoeuvre, others leave you space, width	
Knowledge about where you can go/right of way, **and information**, signage and directions, education	
Tolerance/respect from others/of other users	
Consistency of road and path design	
Safe	Increasing importance
Ability to **cross roads** (controlled crossings, priority)	
Appropriate speeds	
Enforcement, regulations etc.	
Connectedness of network	
Accessibility	
Accommodation of all modes (intimidation/feel unsafe)	
Quick emergency response times	
Being seen (road layout for visibility, driveways)	
Feeling you **belong**	
Ability to **pull over** (shoulders)	
Stopping and **rest areas**	
No obstacles (e.g. signs)	
No congestion (timeliness, frustration)	High importance

Figure AVIII.7: Critical comfort factors (irrespective of mode)

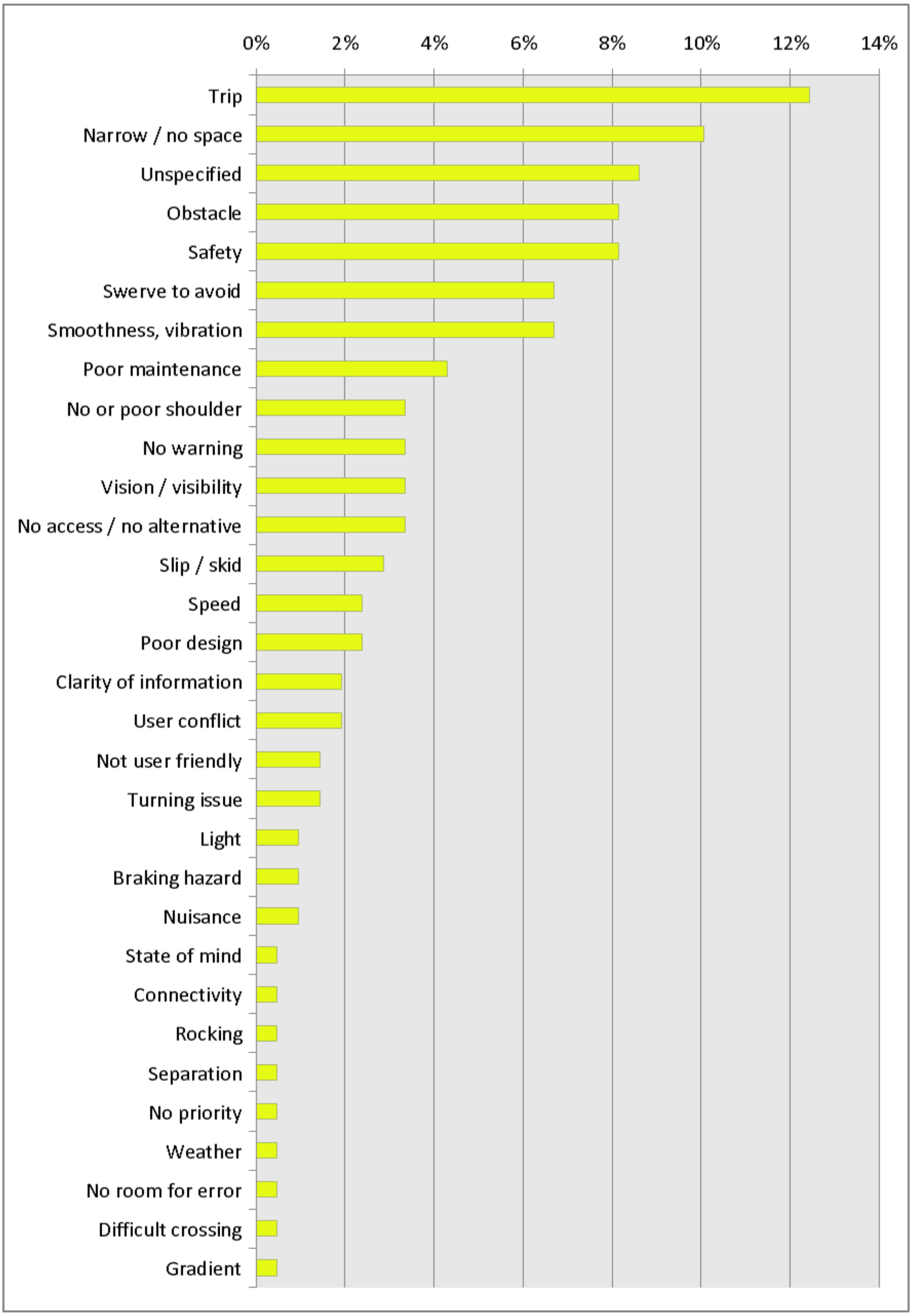


Figure AVIII.8: All identified pavement issues

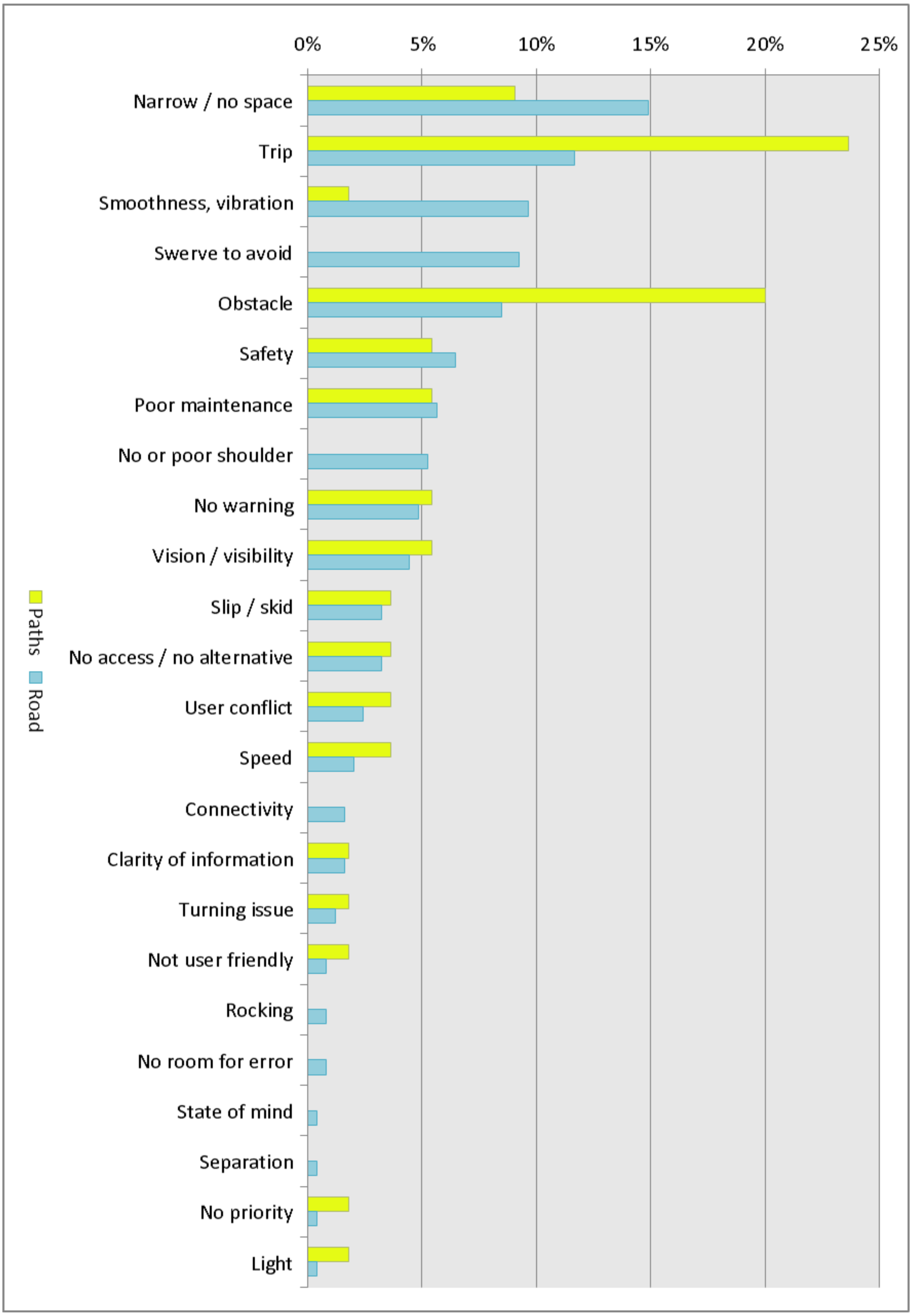


Figure AVIII.9: Key pavement issues for the top 50 ranking photographs

Figure AVIII.8 highlights the importance of potential trip hazards to customers, followed closely by the interlinked issues of narrowness/reduced space, and the presence of obstacles. Of note is the pairing of the surface issues with the issue of defects causing customers to swerve (whether into oncoming traffic, or in the case of cyclists, into the live traffic lane). These were clearly linked in customer's minds as they noted that it was not so much about smoothness, but *where* defects were located. The effect of defects in the ride- or wheel-line not only caused discomfort from bumping, but also from swerving to avoid the issue and creating another comfort issue; that of uncertainty or feeling unsafe from reduced separation caused by the need to swerve into the live traffic lane. Customers indicated that this was also linked to the presence and quality of shoulders (extent of pavement/pavement level changes) discussed earlier.

Figure AVIII.9 considers the top 50 ranked photographs in more detail. Given most of the identified issues pertained to cyclists and pedestrians, this analysis indicates that whilst relatively fewer issues were identified on paths, these user groups have a wide range of road-related issues.

Piloting the questionnaire

The piloting of the questionnaire confirmed the length of the survey as being suitable. Minor refinements were made (e.g. to some of the terms used and the ranking criteria). The major addition was the inclusion of 'potential customers' and questions relating to mode uptake and barriers to modes and user groups.

AVIII.2 Survey

AVIII.2.1 Survey methods

Survey logistics

The second stage of this study entailed a comprehensive online survey (Appendix IX). The survey is distinctive by being developed in conjunction with customer groups; a noted lesson derived from cultural safety practice in New Zealand healthcare (Koptie, 2009; Ramsden & Spoonley, 1993). It therefore sought to approach the underlying question from the customer perspective rather than that of a technical paradigm and built upon the customer workshops just described.

Although originally designed to enable people using non-vehicular modes to comment on roads, limitations required some modal segregation. However, pedestrians and those using non-vehicular modes are road users, so this is an important issue yet one not often addressed in surveys of road use. The survey sought to recognise this incongruence within path-related questions. It also treated cyclists and bus passengers as hybrid categories that may use either roads or paths (the latter because getting to a bus stop is integral to their journey). Road and path use are therefore generalised terms used for convenience, and of course should not be taken to mean that pedestrians and other path users are not road users also.

The NZTA hosted the survey on its webpage, project websites, and promoted it via all its electronic media channels. Links were also sent to earlier workshop participants and various interest groups. The survey was available for two months, and a total of 1,648 responses were volunteered across this period. A single, manual response was entered into the dataset prior to validation and analysis. Data was also screened to check for issues using a defined set of criteria (e.g. eliminating responses where only basic ethnographic data had been completed); this gave a total of 1,619 usable responses.

This was a lengthy survey (but within the time limits defined within the workshops). Whilst the survey is representative, it is nonetheless a snapshot at this current time; the potential for change does not negate the findings here, it does underline the importance of not relying on high-level satisfaction surveys for extended periods. Things change, so there is a need to periodically complete a deep dive to reflect on the evolving context and customer need.

Analysis of data

Most of the quantitative data was managed through Excel. Qualitative data involved the coding of survey responses, which followed the emergent coding practice previously described in Section 3.1, except that instead of NVivo, Excel was used to record and graph the outputs.

AVIII.2.2 Survey results

This Section follows the survey structure (Appendix IX) and responds to each of the questions in turn:

- Section 1: Basic ethnographic data (Section AVIIIX.2.2.1; survey Q1-3). Enabled an assessment of representativeness to be made.
- Section 2: Replication of current survey conventions (Sections AVIII.2.2.2-AVIII.2.2.5; survey Q4-11). Enabled a comparison with current surveys. Note:
  - this section included two new questions (Q5-6) to investigate barriers to mode use uptake; and
  - the terms used in Q11 are derived from current convention. The point here is that the terms are open to interpretation (not least between customers and practitioners). This was discussed within the preceding workshops, which confirmed issues with interpretation. It emerged from separate discussions (with practitioners) that such lists were typically generated by practitioners (Section 7.1), who selected not only the terms used, but the range of matters to choose from.

  - Section 3: Exploration of comfort (Sections AVIII.2.2.6-AVIII.2.2.8; survey Q12-20). These questions augment the exploration of comfort from first principles and enable consideration of the findings relative to the current performance indicator and stated strategic intent. The range of factors, and the terms used were refined and developed with within the preceding customer workshops.

The final two sections of the analysis (AVIII.2.2.9-AVIII.2.2.10) look at the results in terms of how the current performance measure is framed and directed. This is a cross-analysis of two matters arising from the survey (the complexity of comfort and the role of comfort in mode augmentation and general satisfaction).

AVIII.2.2.1 Survey representativeness

Although the workshops provided useful insights, these involved only a few participants. The survey was therefore aimed at canvassing a wider customer cross-section.

Bryman (2001) records that social research typically aims for a 95% level of confidence (with an associated margin of error of 1.96%). The survey achieves this as a subset of the New Zealand population (4,355,739 (Statistics New Zealand, 2013a)).

Basic ethnographic data (age, gender, geographic distribution) were also compared with the 2013 New Zealand Census (Ibid.). Regression analysis across a combined list of all three factors gave a relatively good correlation between survey and Census (r=0.87).

Overall, it is considered that the survey is statistically significant and is reasonably representative of the wider New Zealand population.

AVIII.2.2.2 Mode use

Respondents were asked to indicate the forms of transport they currently use to travel on roads or footpaths, and were then asked to state the modes they would like to use but do not do so currently (Table AVIII.3). Potential customers do not appear to be approached often in infrastructure satisfaction surveys, and the question was included after workshop feedback. More than one mode was able to be selected in each case.

Table AVIII.3: Mode use

Mode or User Group	Current mode use	Additional mode use sought
Road Modes		
Car driver	87%	5%
Car passenger	60%	2%
Motorcyclist/scooter	10%	7%
Light commercial vehicle	5%	<1%
Truck	3%	1%
Bus driver	1%	1%
Both Road and Path Modes		
Bus passenger	37%	17%
Cyclist	43%	19%
Path Modes		
Pedestrian	84%	3%
Pedestrian with pram or pushchair	11%	1%
Wheel chair or mobility scooter	6%	2%
Skateboard/long-board/push-scooter	3%	<1%
Horse	1%	2%
Other	1%	3%

Car travel dominated current mode use, with car drivers and passengers accounting for 42% of total mode usage. However, pedestrians were also dominant. Five of the 13 defined mode or user groups accounted for 89% of the total current modal use.

54% of the survey indicated that they would like to augment their current mode (1.4 additional modes sought on average). A strong preference was expressed for cycling or bus patronage, which accounted for 57% of all additional mode usage sought. However, this is not necessarily latent demand, as respondents noted a range of scenarios, including modes that were:

- used previously but which had been given up; and
- currently used but which the customer would like to use more than at present.

AVIII.2.2.3 Barriers to mode augmentation

Respondents were also given the opportunity to comment on the barriers affecting their use of other modes (Table AVIII.4). Approximately 40% elected to do so, giving rise to 1,199 barriers in total across 59 individual issues. The two most sought additional modes (cycling and bus patronage) identified the widest range of barrier issues; 71% (42/59 barrier issues) and 64% (38/59 barrier issues) respectively (Table AVIII.4). These two modes, together, accounted for 78% of all the barriers (i.e. 935/1,199).

Table AVIII.4: Key barrier factors to the uptake of additional modes

Mode or User Group	Range of Individual Issues Identified *(n=59)*	Proportion of the Total Number of Barriers Identified (n=1,199)	Top Ranked Barrier Issues *(1= top ranked)*
Road Modes			
Car driver	14%	1%	1. Traffic environment 1. Cost of service/relative cost 1. Technology gap
Car passenger	17%	2%	1. No facilitated provision for carpooling 2. Cost of service/relative cost 2. Trip duration, time
Motorcyclist/ scooter	29%	4%	1. Safety 2. Cost of service/relative cost 3. Weather
Light commercial vehicle	0%	0%	Not applicable

Mode or User Group	Range of Individual Issues Identified *(n=59)*	Proportion of the Total Number of Barriers Identified (n=1,199)	Top Ranked Barrier Issues *(1= top ranked)*
Truck	0%	0%	Not applicable
Bus driver	3%	<1%	1. Scared or frightened 1. Confidence
Both Road and Path Modes			
Bus passenger	64%	35%	1. Accessibility of mode 2. Timetabling of service 2. Cost of service/relative cost
Cyclist	71%	43%	1. Safety 2. No or few separate assets 3. Shared space issues 3. Lack of width, narrow spaces
Path Modes			
Pedestrian	41%	6%	1. No or limited asset 1. Safety 1. Poor condition, quality of asset
Pedestrian with pram or pushchair	27%	2%	1. Speed environment 2. No or limited asset 2. Safety 2. Obstructions 2. Pollution
Wheel chair or mobility scooter	25%	2%	1. Rough or uneven surfaces 1. Accessibility of mode 2. Shared space issues 2. Interface between paths and road
Skateboard/long-board/push-scooter	22%	2%	1. Rough or uneven surfaces 2. Safety 3. Shared space issues

Mode or User Group	Range of Individual Issues Identified *(n=59)*	Proportion of the Total Number of Barriers Identified (n=1,199)	Top Ranked Barrier Issues *(1= top ranked)*
Horse	12%	1%	1. Safety 2. Shared space issues 3. No or few separate assets 3. Design issues 3. Accessibility of mode 3. Trip duration, time 3. Rule clarity
Segway	14%	1%	1. Rule clarity 2. Safety 2. Rough or uneven surfaces 2. Trip duration, time
Other	10%	1%	1. Current technology gap 2. Accessibility of mode 2. Pollution

The main modes concerned with the issue of surface roughness and unevenness were path users and in particular, skateboarders/push scooters, followed by pedestrians and wheelchair or mobility scooter users. However, the issue only accounted for 2% of the total number of barrier issues raised.

By contrast, 'accessibility', which affected an equally diverse number of modes or user groups, was identified more frequently as a barrier. 'Accessibility' was most significantly a barrier to the uptake of bus patronage (both generally and for those with mobility constraints), and to a lesser extent, for cyclists also. Whilst accessibility itself is often managed in transportation operations through simplified metrics such as travel time, feedback from this survey tends to support research which highlights the complexity of this factor and in particular the role of *usability* (Geurs & van Wee, 2004; Iwarsson & Ståhl, 2003), for example the ability to manoeuvre wheelchairs or prams on/off a bus.

Overall, the most frequent barrier issue was identified as safety (15% of all issues) and that the group most concerned with this are potential cycling customers. The second most prevalent barrier relates to where there are 'no or few separate assets or ability to access a separate facility' (7% of the overall issues; or 11% when combined with the interlinked issue of shared space).

AVIII.2.2.4 Levels of satisfaction

A common strategy in general customer surveys is to assess the degree of satisfaction with a given outcome or asset, and then to ask customers to rank or provide feedback on a range of given parameters. Respondents were generally satisfied with both roads and paths (Figure AVIII.10). This is important to recall when considering other feedback. Indeed, responses were sometimes prefaced 'generally good, but…'. Furthermore, whilst satisfaction surveys may enable comparison over time, there may be an element of 'expectation adjustment'. Consequently, satisfaction aligns with a given context, defined level of service, and other conditioning factors (e.g. vehicle condition, suspension).

The general satisfaction question also provides a degree of benchmarking with past NZTA surveys and the context for subsequent questions on the relevance and attributes of comfort. The NZTA currently surveys 1,000 customers every quarter to assess their satisfaction with the State highway network (NZTA, 2015b). Comparison with this survey (Figure AVIII.10) shows that whilst the proportions of average performance are similar, customers were slightly more satisfied with the State highway network than New Zealand's roads and paths more generally. This might infer that customers are less satisfied with local roads, which could indeed be the case (and was suggested by survey feedback). However, this may not be the singular reason and the following observations are made in this regard:

- The State highway surveys specifically excluded local roads, and could be interpreted as also excluding urban sections of the State highway (NZTA, 2015b). In smaller rural towns, the highway may have adjacent paths, and customers are not necessarily aware of, nor cared for, administrative boundaries (workshop feedback, survey responses).

Figure AVIII.10: Overall road and path satisfaction (and comparison with State highway satisfaction surveys)

Source: Results from past NZTA surveys obtained with permission (NZTA, 2015b).
Note: 'Other modes' refers to walking and cycling only.

- The State highway surveys also focus on driver or vehicular experience (e.g. "*Maintaining the road surface so that it is safe to drive on*"; NZTA (2015b)). Whilst non-drivers are recorded, wording inclines towards vehicle passengers (e.g. "*Please select the frequency in which you use (as a passenger or driver) State Highways*"; Ibid.). However, the highway survey does ask how well the NZTA recognises and responds to the needs of different types of highway users such as cyclists and pedestrians. Responses to that question show a much closer alignment with this survey (Figure AVIII.10). This may suggest a higher proportion of non-vehicular customers responding to this survey (perhaps as a consequence of distribution to interest groups), or respondents taking a broad approach (e.g. "*Roads are built excellent (1) for being a car driver/passenger, but are built to very poor (5) for cyclists*."; Ibid.).

A range of factors may therefore have contributed to the differences in satisfaction, and may not be as simple as the inclusion of local road infrastructure. This is an area for further exploration.

Customers were also given the opportunity to clarify their general satisfaction responses in an open-ended question; 59% (roads) and 45% (paths) elected to do so. This gave rise to a large range of issues which provided a richness of detail otherwise not apparent at the higher level (summarised in Figure AVIII.11).

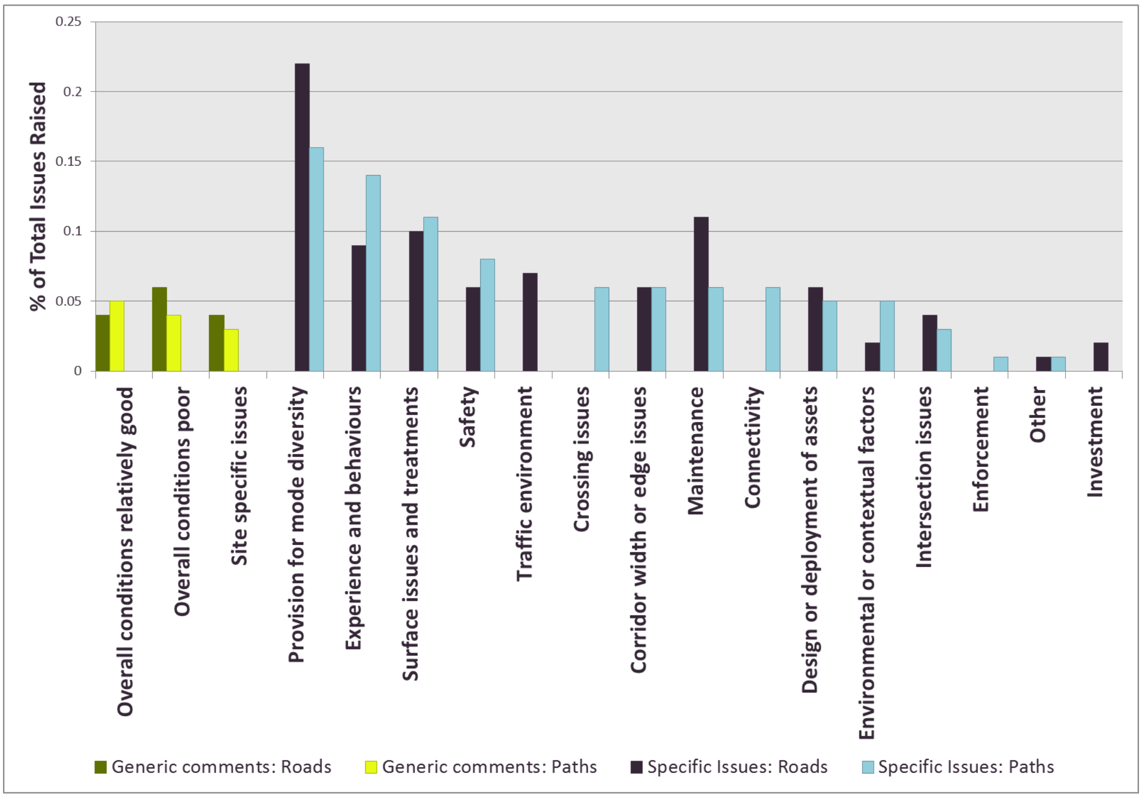


Figure AVIII.11: Summary of issues arising from general satisfaction with roads and paths

Note: Summarised from 79 individual road and 62 individual path issues.

At the summary level, by far the most significant road-related category related to provisions for mode diversity, followed by issues around maintenance, surface treatments, and customers' experiences and behavioural factors. Interestingly, traffic conditions such as congestion, which is often a transportation sector focal point, ranked fifth.

Of the 79 individual road-related concerns identified (not plotted but integrated within Figure AVIII.11), 'maintenance responses and strategies' attracted the largest number of comments. The general tenor of comments expressed a sense of frustration at the level of rework occurring on New Zealand roads. There were two dominant aspects to this:

- the reworking of roads where the customer did not perceive a need for maintenance (leaving 'worse' areas untouched); and
- the current strategy of patching. Customers consider this creates rough edges and bumps, does not last, and results in more disruption and a degraded outcome overall.

The next two highest individual issues relate to a perceived lack of provision for cyclists and the closely related matter of cycle lane connectivity and quality. Comments relating to these highlighted issues with a singular approach given the breadth of cycling user groups: commuters, children or families, disabled users (e.g. using hand-bikes), and recreational cyclists of various levels (from those just wanting to do a bit of exercise, to others who indicated more extensive cycling usage).

With respect to road surfacing (which underlies this study), general road surface conditions accounted for 3% of the issues raised. However, customers were also concerned with a range of other factors which could arguably contribute to a generic question on road surface conditions. These include:

- maintenance strategies and practice (including the quality of repairs and utility works);
- no or inadequate shoulders (extent of road surface or seal);

- other surfaces (e.g. loose gravel, metal covers);
- surface treatments (e.g. slippery cobblestones);
- bumps around manholes and the edge of repairs;
- interfaces between areas (path to road, train tracks etc.);
- corrugations, undulating or generally bumpy surfaces;
- tar melts, bleeds and flushing (where "*new layers of chip seal are rapidly embedded into the underlying layer*" creating smooth or 'flush' surfaces; NZTA (2000));
- issues in the ride-line or corners; and
- issues that force users to swerve (into a live lane, or to move off the road).

Together, these account for another 18% of the total number of issues, and begin to highlight the complexity of road surface issues when considered from the customer's perspective.

Aligning with the feedback for roads, provision for mode diversity (or the range of modes and user groups competing for path space, and the relative priority these are given when interfacing with the road) was by far the most significant path category at the summary level (Figure AVIII.11). Whilst maintenance was not within the top four path categories, 'customers' experiences and behavioural factors' and 'surface treatments' (both within the top four for roads) placed second and third respectively. Safety was the fourth ranked category (and was closely aligned with the crossing and intersection categories, which collectively account for 17% of the total issues raised).

Of the individual concerns identified (not plotted, but integrated within Figure AVIII.11), the three top issues were as follows:

- **The broken or generally bumpy condition of paths:**
  Whilst maintenance and the poor condition of paths did attract a significant number of comments, a great many of the issues related to the design of the paths themselves. Bumpy and undulating conditions were noted from the design of vehicle accessways, path depressions at crossing points, the transitions with the road and traffic islands, for example. Customers noted that this made it difficult for path users; particularly the very young (or those pushing prams), those using mobility devices, or the less mobile and elderly. These

issues were often exacerbated by other factors such as overhanging vegetation or parked cars, which reduced customer choice, experience, and frequently forced customers on to grassed verges or the road.

- **Safety issues:**
  The broken and bumpy condition of paths was one of the important factors contributing to perceived or actual safety issues through the risk of getting stuck, tripping, tipping over, or breaking mobility devices. Another key issue was the lack of paths, or the practice of installing paths only on one side of a road as this either forced customers on to the road (where often busy roads or inadequate shoulders then became an issue), or forced the customer to cross the road. However, the most commonly identified safety issue related to the frequency and design of crossing points and the nature of intersections. Customers indicated that they would avoid crossing points they perceived (or had experienced) as being dangerous. Roundabouts were often cited as problematic, along with driver behaviour, vehicle dominance, and the design of kerb depressions (frequency, location, width, steepness, paving transition etc.). Several people noted that they used their car more as a consequence.
- **Narrow or inadequate space:**
  Narrow paths were considered to be especially difficult to use if you wished to walk side by side, needed to manage small children, or were in a mobility device. Whilst there was an interface with path obstruction issues, often paths were identified as inappropriately narrow by design.

Path surface conditions do not contribute to the measure of road smoothness (the focus of the wider study). However, this highlights the importance of physical and behavioural interfaces with paths, and the condition of roads to those who may be crossing the road or are otherwise forced to walk on or alongside the road due to other factors.

AVIII.2.2.5 Relative importance of comfort

The next survey question looked at how customers see the relative importance of a range of given high-level factors. The purpose was to contextualise the importance of comfort (as a high-level concept) within a range of typical transportation indicators used by industry. Whilst listed as separate or discrete concepts, the previous workshops indicated that the issues were in fact intertwined.

Of all the issues, comfort was closest to being neutrally ranked (i.e. 55% of customers' ranked comfort within the top six; 45% in the bottom six), and was ranked 7th of the 12 given issues (Figure AVIII.12). Safety and accessibility were seen as the two most important issues; comments again underlined the value of looking beyond an assumed or technical interpretation of these terms, and indeed, in engaging with the community.

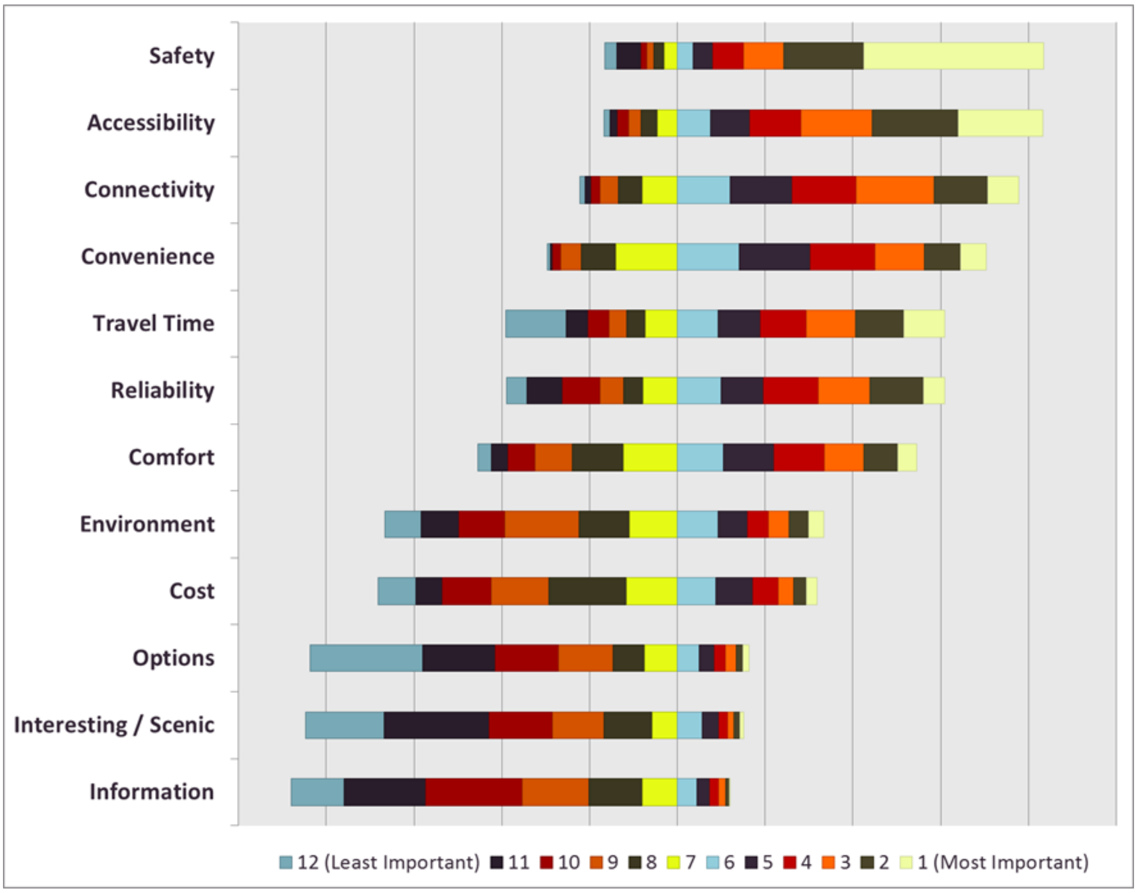


Figure AVIII.12: Relative importance of issues

AVIII.2.2.6 Overall journey comfort

Figure AVIII.13 presents the results of how customers view their overall journey comfort. Of the 13 mode or user groups, all but one of the seven most comfortable mode or user groups are vehicular; car drivers and passengers being the most comfortable overall. The most comfortable of the non-vehicular modes are pedestrians (5^{th}). The least comfortable are those customers in wheelchairs or users of mobility scooters, closely followed by horse riders. The remainder of this Section explores comfort in more detail.

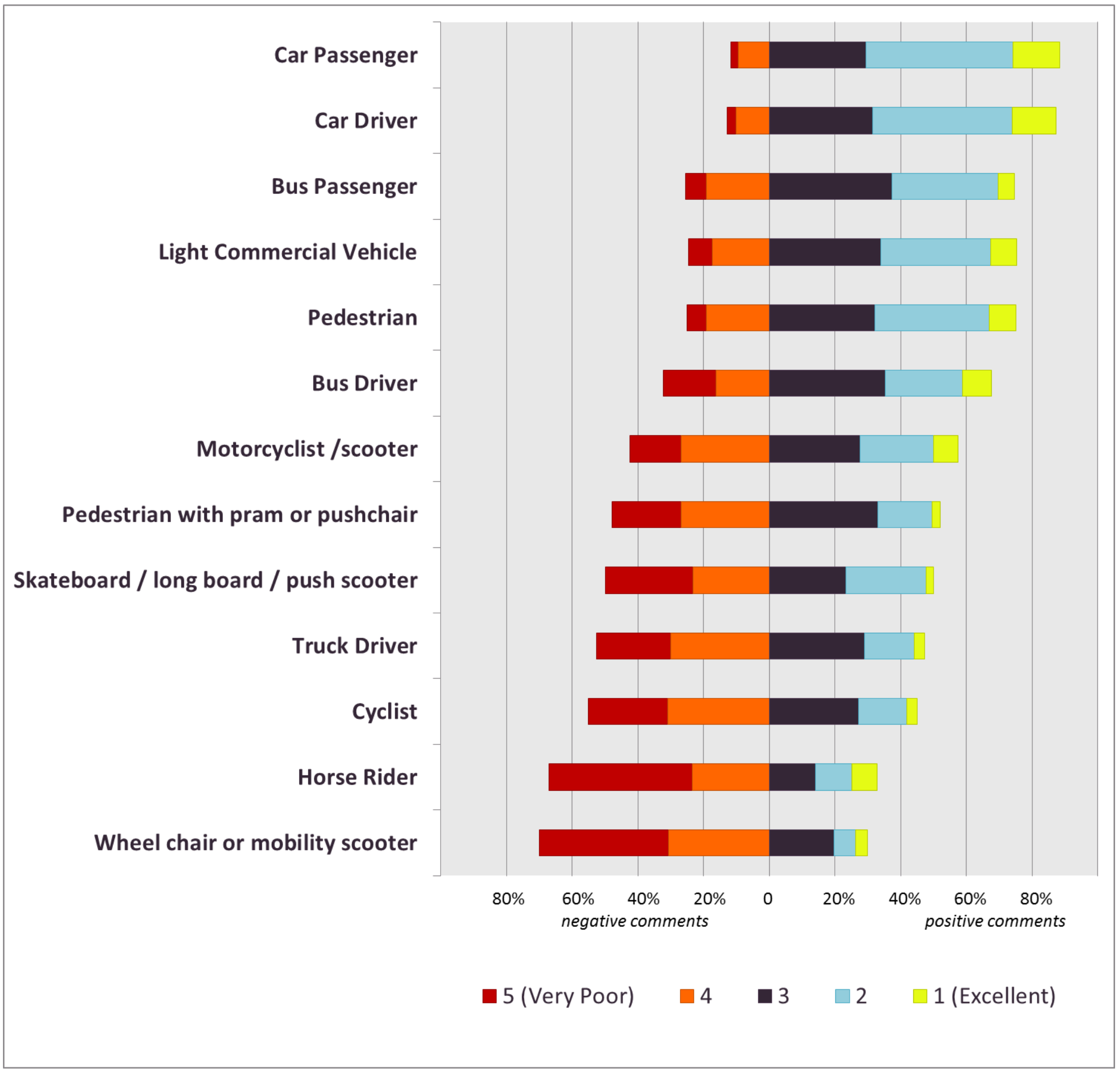


Figure AVIII.13: Overall journey comfort

AVIII.2.2.7 Road comfort factors

A range of road-related comfort factors were identified and developed as part of earlier customer workshops and piloting of the questionnaire. Customers were asked to identify those affecting their comfort (Table AVIII.5).

Overall, 'appropriate speeds' was most the frequently identified factor affecting road mode or user group comfort; appearing within the three most frequently identified factors for all road modes or user groups with the exception of cyclists and motorcyclists/scooters. Customers were given the opportunity to clarify their answers and this gave rise to a range of (sometimes conflicting) views (e.g. speed limits are too high/too low) and issues with a perceived 'one size fits all' or formulaic approach. Responses also highlighted a behavioural component, such as bus drivers speeding up near bus stops or traffic lights.

Table AVIII.5: Comparison of most frequent road comfort factors

<table>
<tr><th rowspan="2">Mode or User Group</th><th colspan="12">Three Most Frequent Road Comfort Factors</th></tr>
<tr><th colspan="4">1st</th><th colspan="4">2nd</th><th colspan="4">3rd</th></tr>
<tr><td>All modes/user groups</td><td colspan="4">Appropriate speeds</td><td colspan="4">Road roughness and defects</td><td colspan="4">Other's behaviour</td></tr>
<tr><td>Car driver</td><td colspan="4">Appropriate speeds</td><td colspan="4">Other's behaviour</td><td colspan="4">Traffic conditions</td></tr>
<tr><td>Car passenger</td><td colspan="4">Appropriate speeds</td><td colspan="4">Road roughness and defects</td><td colspan="4">Other's behaviour</td></tr>
<tr><td>Cyclist</td><td colspan="3">Other's behaviour</td><td colspan="3">Road roughness and defects (2nd=)</td><td colspan="3">Safety issues (2nd=)</td><td colspan="3">Road surface texture (2nd=)</td></tr>
<tr><td>Motorcyclist/ scooter</td><td colspan="4">Potholes</td><td colspan="4">Slippery surfaces</td><td colspan="4">Road roughness and defects</td></tr>
<tr><td>Light commercial vehicle</td><td colspan="4">Appropriate speeds</td><td colspan="4">Road roughness and defects</td><td colspan="4">Other's behaviour</td></tr>
<tr><td>Truck</td><td colspan="4">Appropriate speeds</td><td colspan="4">Road roughness and defects</td><td colspan="4">Potholes</td></tr>
</table>

Mode or User Group	Three Most Frequent Road Comfort Factors		
	1st	2nd	3rd
Bus driver	Appropriate speeds	Traffic conditions	Road roughness and defects
Bus passenger	Connectivity and accessibility	Appropriate speeds	Clear and logical information

'Road roughness and defects' was also a frequently identified issue for most modes; the exceptions being car drivers and bus passengers. This is interesting given the focus on the drive-line of four-wheeled vehicles inherent within the methods for measuring road smoothness. Comments related to road roughness and defects reinforced both its general importance and also the observations from the earlier focus groups, such as the importance of road shoulders, surface debris and its location, loss of grip/ultra-smooth surfaces, kerb transitions (kerb height and pavement interface), and user preference. Maintenance practices (quality of workmanship, responsiveness) were also often identified within this theme.

Other frequently identified issues included 'other's behaviour', 'traffic conditions', 'safety', 'potholes', 'slippery surfaces', and 'road surface texture'. The latter three being closely related to the issue of 'road roughness and defects'. However, the interplay between these issues, and the preferences or needs of different modes is an area for potential conflict. Bus passengers also commonly identified 'connectivity and accessibility' and the need for 'clear and logical information' as comfort factors. Again, many of the associated comments noted that road conditions were 'generally good, but…'. Few new issues were raised; the two more frequent ones being enforcement and issues forcing users into the live lane, off the road, or onto another mode.

After identifying the range of factors that affected their comfort on the road, customers were then asked to select the three most important, and then to rank these (Figure AVIII.14). This shows a clear segregation of the top issues. Again, 'safety issues' was most frequently and singularly identified as one of the 'three most important road comfort issues' for customers. Less notable were 'others' behaviour', 'appropriate speeds', and 'road roughness and defects'. However, all four were relatively dominant by comparison to the other issues.

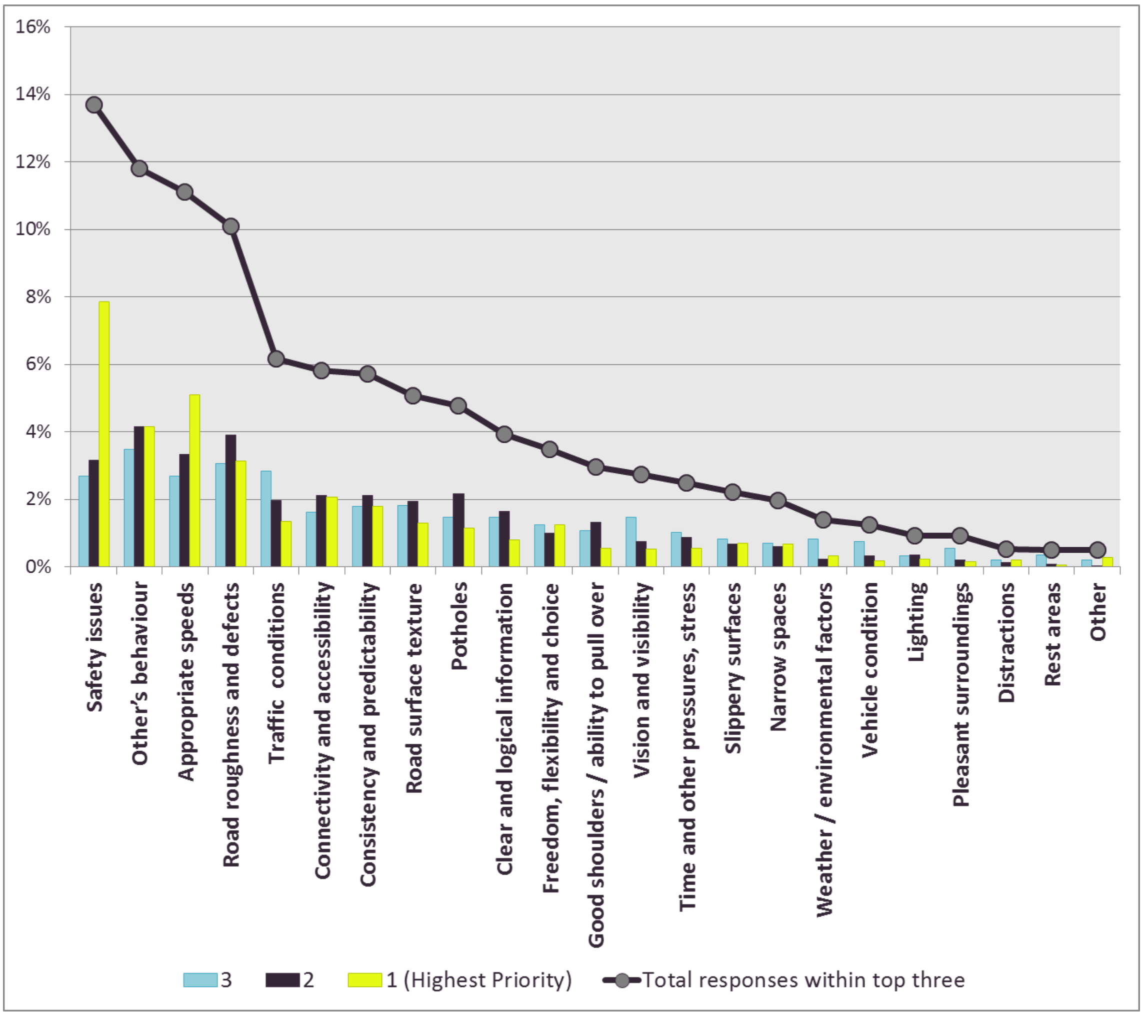


Figure AVIII.14: Frequency distribution of the top three comfort factors: Roads

AVIII.2.2.8 Path comfort factors

As for roads, a range of path-related comfort factors were identified and developed as part of the previous customer workshops. Customers were asked to identify those affecting their comfort (Table AVIII.6).

Table AVIII.6: Comparison of most frequent path comfort factors

<table>
<tr><th rowspan="2">Mode or User Group</th><th colspan="12">Three Most Frequent Path Comfort Factors</th></tr>
<tr><th colspan="4">1st</th><th colspan="4">2nd</th><th colspan="4">3rd</th></tr>
<tr><td>All modes/user groups</td><td colspan="4">Kerbs/transitions with the road/between surfaces</td><td colspan="4">Path roughness, unevenness, and defects</td><td colspan="2">Path width (being able to travel side by side)(3rd=)</td><td colspan="2">Other's behaviour (3rd=)</td></tr>
<tr><td>Bus passenger</td><td colspan="4">Connectivity and accessibility</td><td colspan="4">Clear and logical information</td><td colspan="4">Safety issues</td></tr>
<tr><td>Cyclist</td><td colspan="4">Traffic separation</td><td colspan="4">Kerbs/transitions with the road/between surfaces</td><td colspan="4">Path width (being able to travel side by side)</td></tr>
<tr><td>Pedestrian</td><td colspan="4">Path width (being able to travel side by side)</td><td colspan="4">Path roughness, unevenness, and defects</td><td colspan="4">Kerbs/transitions with the road/between surfaces</td></tr>
<tr><td>Pedestrian with Pram or Pushchair</td><td colspan="4">Kerbs/transitions with the road/between surfaces</td><td colspan="4">Path width (being able to travel side by side)</td><td colspan="4">Path roughness, unevenness, and defects</td></tr>
<tr><td>Wheel Chair or Mobility Scooter</td><td colspan="4">Path roughness, unevenness, and defects</td><td colspan="4">Kerbs/transitions with the road/between surfaces</td><td colspan="4">Path steepness</td></tr>
<tr><td>Horse</td><td colspan="2">Other's behaviour</td><td colspan="2">Safety issues</td><td colspan="2">Over-hanging vegetation/ obstruc-tions(2nd=)</td><td colspan="2">Traffic separation (2nd=)</td><td colspan="2">Con-sistency and pre-dictability (2nd=)</td><td colspan="2">Freedom, flexibility and choice(2nd=)</td></tr>
<tr><td>Skateboard/ Long-board/Push-scooter</td><td colspan="3">Path roughness, unevenness, and defects</td><td colspan="3">Kerbs/transitions with the road/between surfaces(2nd=)</td><td colspan="3">Other's behaviour(2nd=)</td><td colspan="3">Potholes(2nd=)</td></tr>
</table>

‘Kerbs/transitions with the road/between surfaces’ was most the frequently identified factor affecting path mode or user group comfort. This issue appeared within the three most frequently identified factors for all path modes or user groups with the exception of bus passengers and people riding horses. Customers were given the opportunity to clarify their answers or to comment further and many elected to do so, for example:

> *Even, wide surfaces are important. Need to consider good access free of barriers/obstacles for prams, wheelchairs and other people with mobility impairments as a priority issue. Currently there are a number of areas* [...] *which have issues for these users at present, which would be relatively low cost to fix. For example, the pedestrian crossing in* [location] *does not have a smooth transition from road to kerb* [...] *and just the other day I witnessed a wheelchair user having immense difficulty here. This would be a very easy issue to fix.* [SR913]

‘Path roughness, unevenness, and defects’ was also a frequently identified category for many modes; the exceptions being bus passengers, cyclists, and those riding horses. Current NZTA measures of comfort and smoothness do not, of course, consider paths.

Bus passengers identified similar comfort factors for the path segment of their journey. By contrast, cyclists identified a different suite of key issues including traffic separation, transitions with the road, and path width. Modal separation was also important to other path users and included intertwined issues such as behaviour, relative speeds, awareness and responsiveness (ability to see or hear approaching cyclists), and adequate space.

Other frequently identified issues included ‘other’s behaviour’, ‘path width (being able to travel side by side)’, ‘path steepness’, ‘safety’, and ‘potholes’. Customers riding horses also identified ‘overhanging vegetation’, traffic separation’, ‘consistency and predictability’, and ‘freedom, flexibility and choice’ as key issues. Many of these were also issues for other mode or user groups but fell outside the three most frequent issues.

Additional comments again largely clarified existing issues with few new issues identified. As for roads, issues that forced users off paths and on to the road were also raised. New issues included shared space, and issues at intersections or crossings, one respondent observing:

> *Lack of pedestrian priority in street design in general is the greatest source of 'discomfort'. There is no greater lack of comfort than being killed or injured by drivers taking the cue given to them by the physical environment that they have total right of way over all more vulnerable users.* [SR1328]

After identifying the range of factors that affected their comfort on paths, customers were then asked to select the three most important, and then to rank these (Figure AVIII.15). By comparison with road comfort, there is less separation of the top issues. In this instance the category 'path roughness, unevenness, and defects' was most often identified within the top three path comfort issues and was relatively clear of the next most frequent issue.

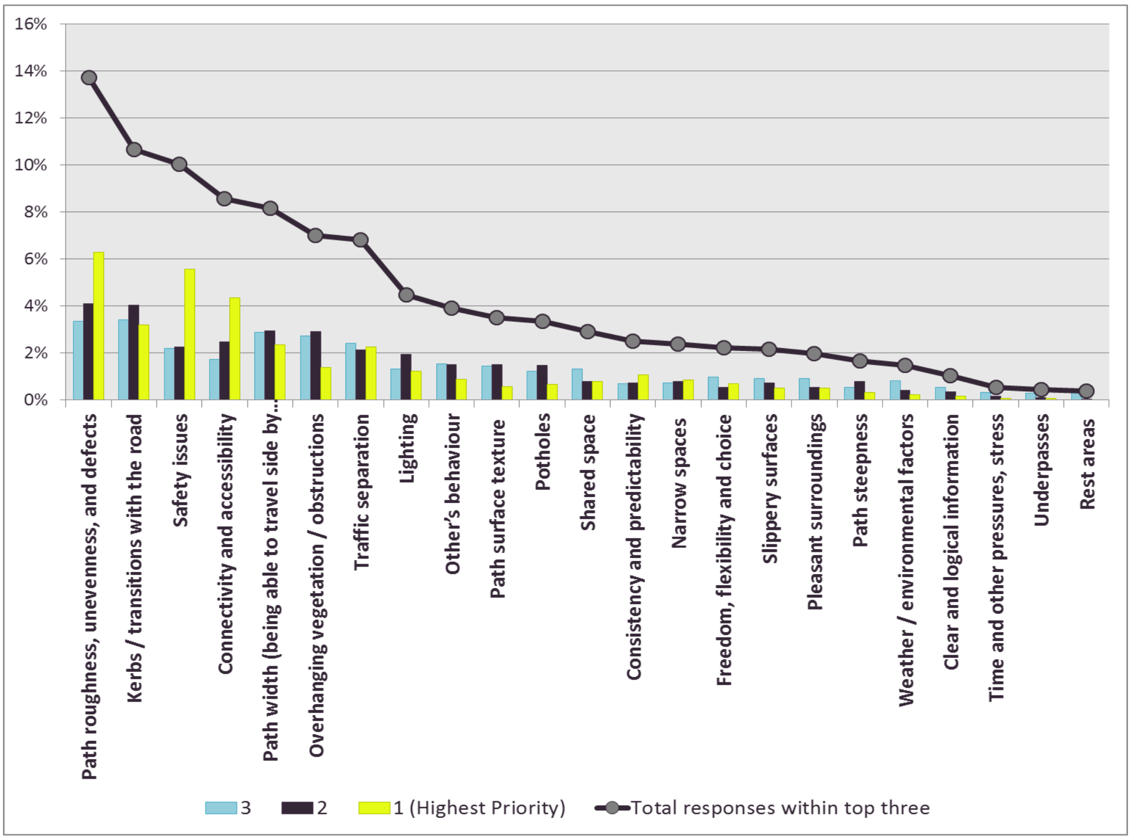


Figure AVIII.15: Frequency distribution of the top three comfort factors: Paths

AVIII.2.2.9 Complexity of comfort

Another way of looking at comfort data is directly in relation to its complexity. This can be seen from the diversity of issues, and in particular the number of times comfort was captured by a single indicator or factor as is presumed by the current measure. Table AVIII.7 shows the frequency that ‘path roughness, unevenness, and defects’ and/or ‘potholes’ was given as the sole comfort factor. Figures AVIII.16–AVIII.17 then look at the distribution across any and all factors. This reinforced the point that wheelchair or mobility scooter users in particular, and to a lesser extent cyclists (on the road) and car drivers have the most complex or diverse range of comfort issues. Very few customers identified only a single factor affecting their comfort.

Table AVIII.7: Occurrence of ‘path roughness, unevenness, and defects’ and/or ‘potholes’ as the sole comfort factor

Mode or User Group	Percentage Occurrence of Roughness or Potholes as the Sole Issue	Percentage of Current Mode Use
Roads		
Car driver	4%	<1%
Car passenger	6%	<1%
Cyclist	1%	<1%
Motorcyclist/scooter	1%	<1%
Light commercial vehicle	0%	0%
Truck	0%	0%
Bus driver	1%	3%
Bus passenger	4%	<1%
Paths		
Bus passenger	<1%	37%

Mode or User Group	Percentage Occurrence of Roughness or Potholes as the Sole Issue	Percentage of Current Mode Use
Cyclist	<1%	43%
Pedestrian	<1%	84%
Pedestrian with Pram or Pushchair	0%	11%
Wheel Chair or Mobility Scooter	1%	6%
Horse	0%	1%
Skateboard/Long-board/Push-scooter	3%	3%

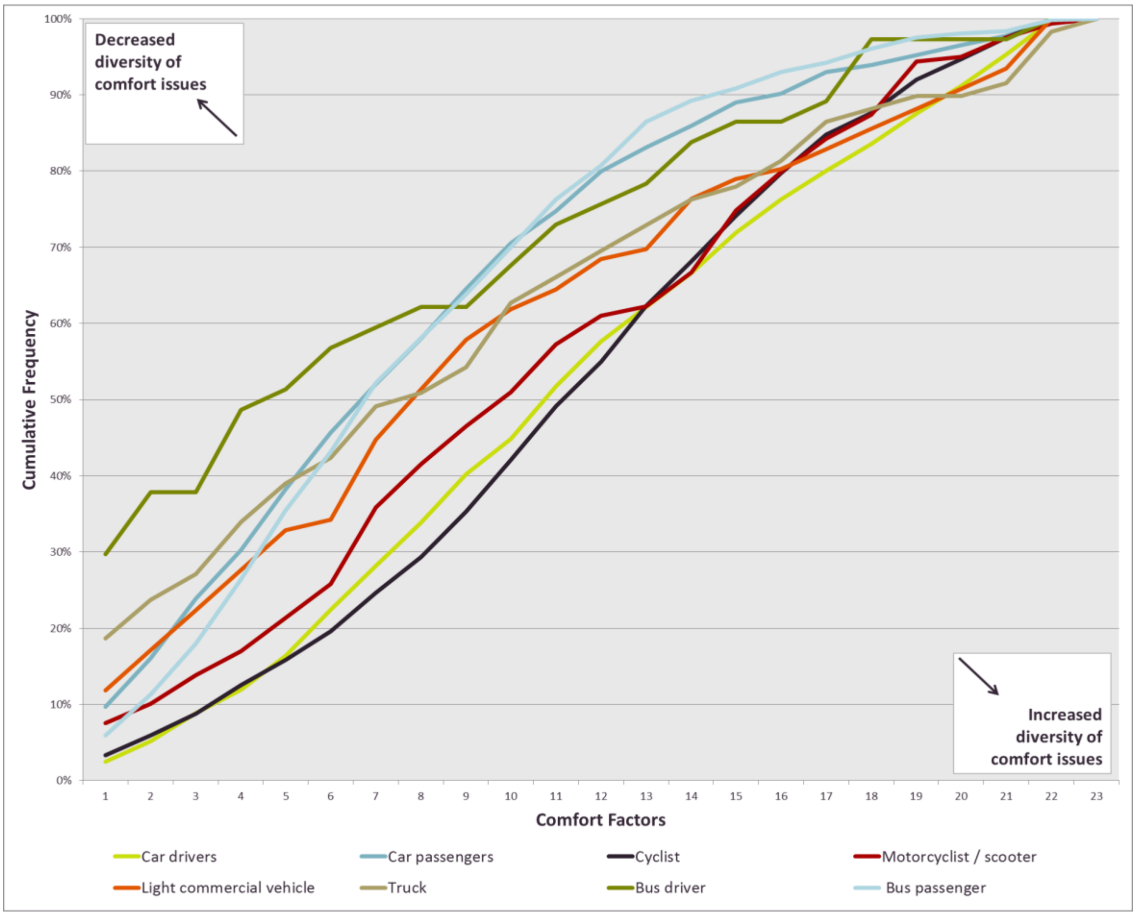


Figure AVIII.16: Diversity of road comfort factors

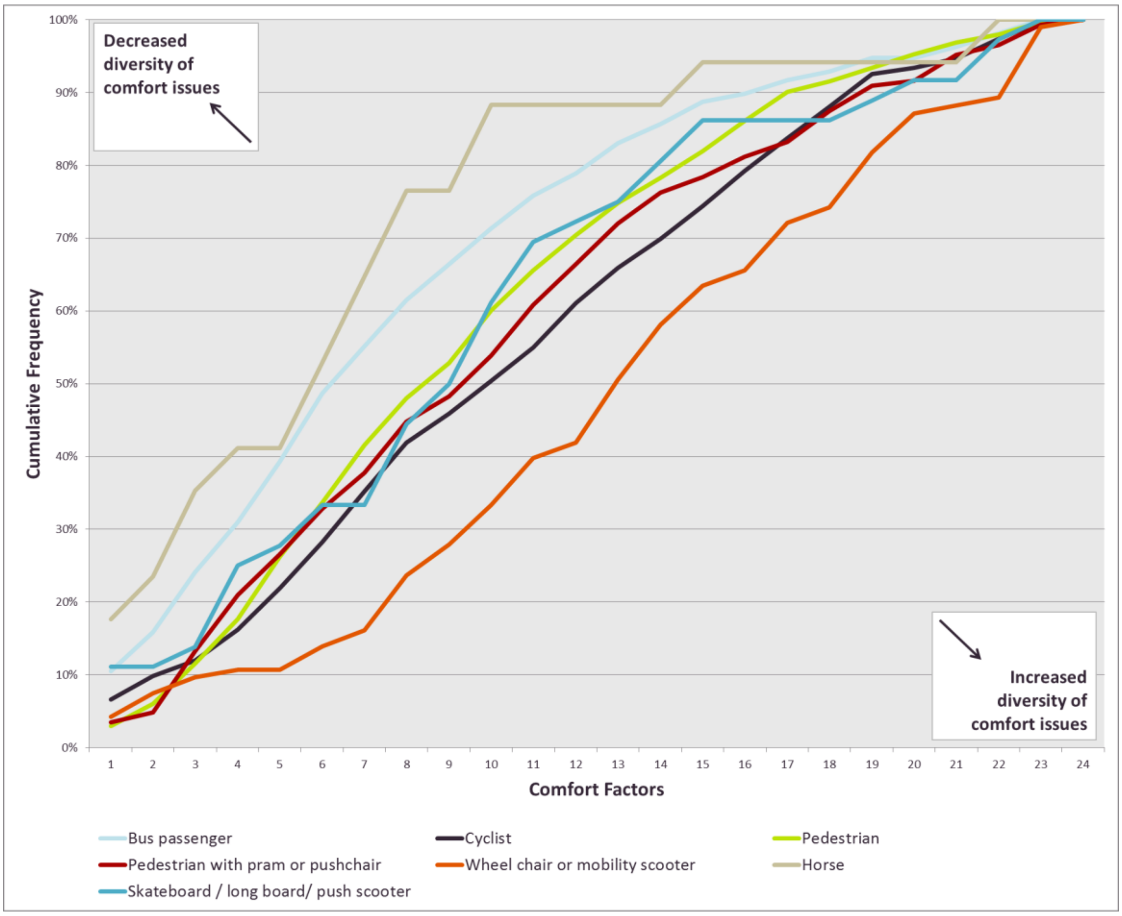


Figure AVIII.17: Diversity of path comfort factors

AVIII.2.2.10 The role of comfort in mode augmentation and general satisfaction

The survey design also enables consideration of the role of comfort in barriers to the uptake of other modes, and general satisfaction. In essence, given comfort complexity, most barriers and comments pertaining to general satisfaction relate to comfort in some way. Consequently, whilst 'comfort' as a singular term might not rank highly in customers' minds, the individual attributes that contribute to the notion of comfort:

- are closely intertwined and often inseparable as comfort factors; and
- contribute to a range of other high-level performance areas (e.g. safety).

AVIII.3 Investigating influence

AVIII.3.1 Investigating influence methods

The final stage of this study involved a two hour workshop with seven managers from the highways operations and customer services teams within NZTA National Office. As the workshop generated a 'local government' node, a secondary one hour workshop was also held with 11 Auckland Transport staff (providing a cross-section of the organisation; e.g. walking and cycling, asset management, code of practice development).

As with the other similar workshops (Chapters 5-6), participants brainstormed matters that would need to be modified within the organisation and wider system to respond to this research (Figure AVIII.18). In this instance, these were written on theme cards and connected with either coloured wool or different coloured whiteboard markers (to represent the formal/informal nature of the relationships between the identified matters).

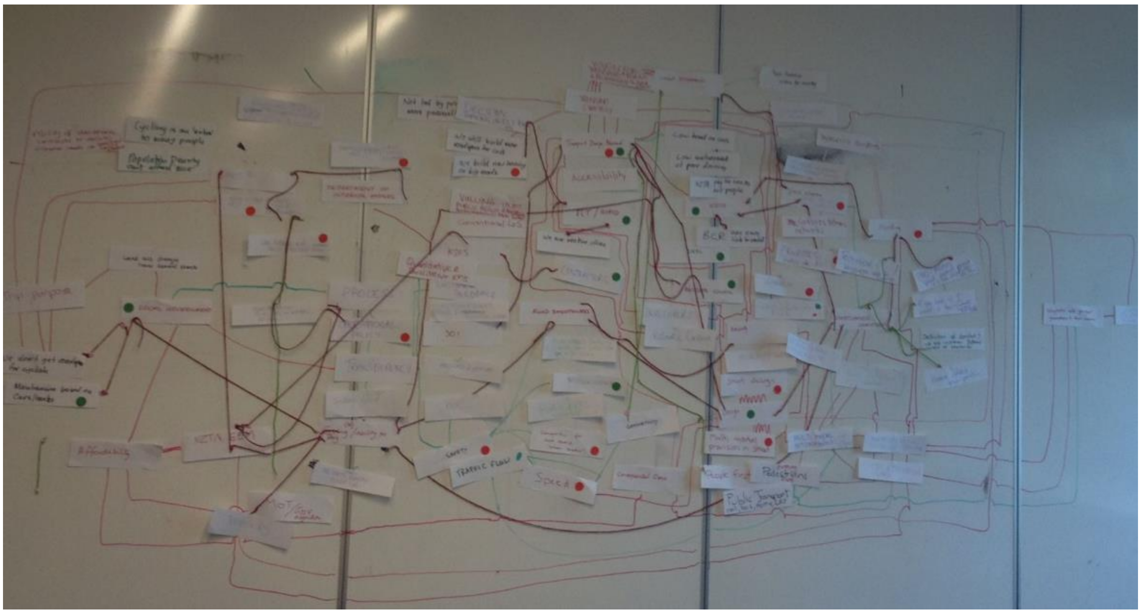


Figure AVIII.18: Raw workshop output (Auckland Transport workshop)

Note: Red lines/string indicates formal relationships; green lines/string indicates informal relationships. This detail was included in the subsequent Gephi 'plots' but not shown in the examples to follow (which instead focus on the relative connectivity and thence likely organisational leverage points or priorities).

Again, the workshop outputs were plotted using Gephi (social network mapping tool). The mapping replicates the connections that were drawn by the workshop participants, but highlights the relative connectivity of each of the nodes (the nodes in this instance being the matters identified within the workshop). This relative connectivity is underpinned by a tool within the programme which calculates the 'betweeness centrality' (or the relative level of connectedness between nodes). Because the workshops generated a rich array of matters the two organisations considered would need to change, the relative connectivity was considered further here.

AVIII.3.2 Investigating influence results

Only limited time was available at the first workshop (NZTA). However, the workshop still generated a wide range of matters; mostly relating to cultural/less tangible factors such as 'tradition' or 'expectation management'.[248] Workshop participants observed that any organisational change would need to extend beyond their part of the business to areas that would not necessarily have been top of mind; challenging the way they both thought of, and approached the issue.

One of the other factors to be identified by the NZTA was 'local government', which is hardly surprising given central government reporting requirements, and the wide spread use of road smoothness as an indicator within the transportation sector. This provided an opportunity to explore and expand the influence networking exercise, and to link both the organisations informing the wider research programme. The outputs from both workshops are shown in Figure AVIII.19.

[248] And so aligning with the similar workshops undertaken as part of the other detailed studies.

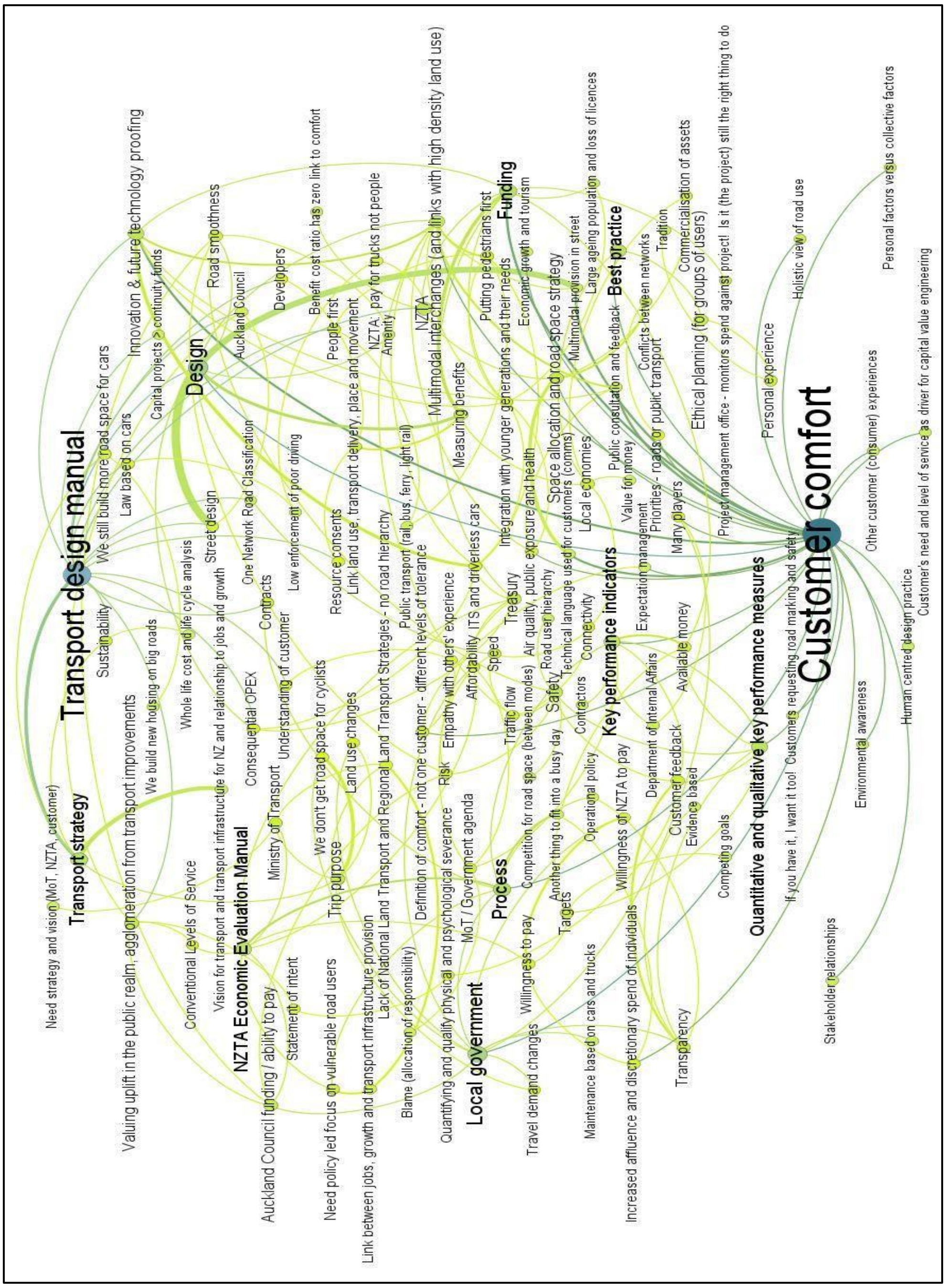


Figure AVIII.19: Influence of the comfort performance indicator

Notes: As defined by NZTA and Auckland Transport workshops. Node and edge (connection) colouring denotes issue or factor communities. Text size indicates the level of influence. The nature of the relationship (formal/informal) was canvassed but is not shown in this instance.

Formal and informal relationships were also explored along with the ability to influence (or merely inform) change. This highlighted further layers of complexity for those who might seek to effect change and buy-in from across the organisation and wider industry.[249]

An alignment was also observed with the four 'problem dimensions' to emerge from the preliminary research (i.e. needs, precepts, choices, and aptitudes; Chapter 3), but with the added dimensions of 'institutions' and 'processes' (Figure AVIII.20). This underlined the point that in addition to procedural change, belief-systems and mental models (precepts) also need to be addressed.

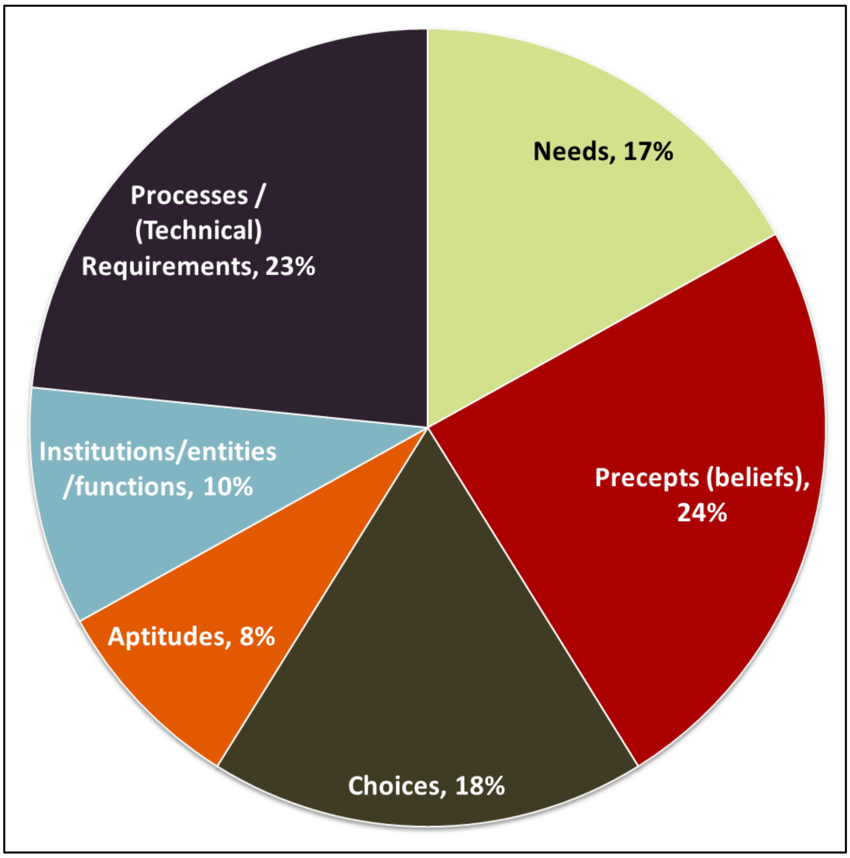


Figure AVIII.20: Nature and distribution of influencing problem dimensions

[249] A task becoming even more challenging in the absence of organisation-spanning roles. This was also raised during the preliminary research interviews, where some interviewees noted these roles were absent, but needed.

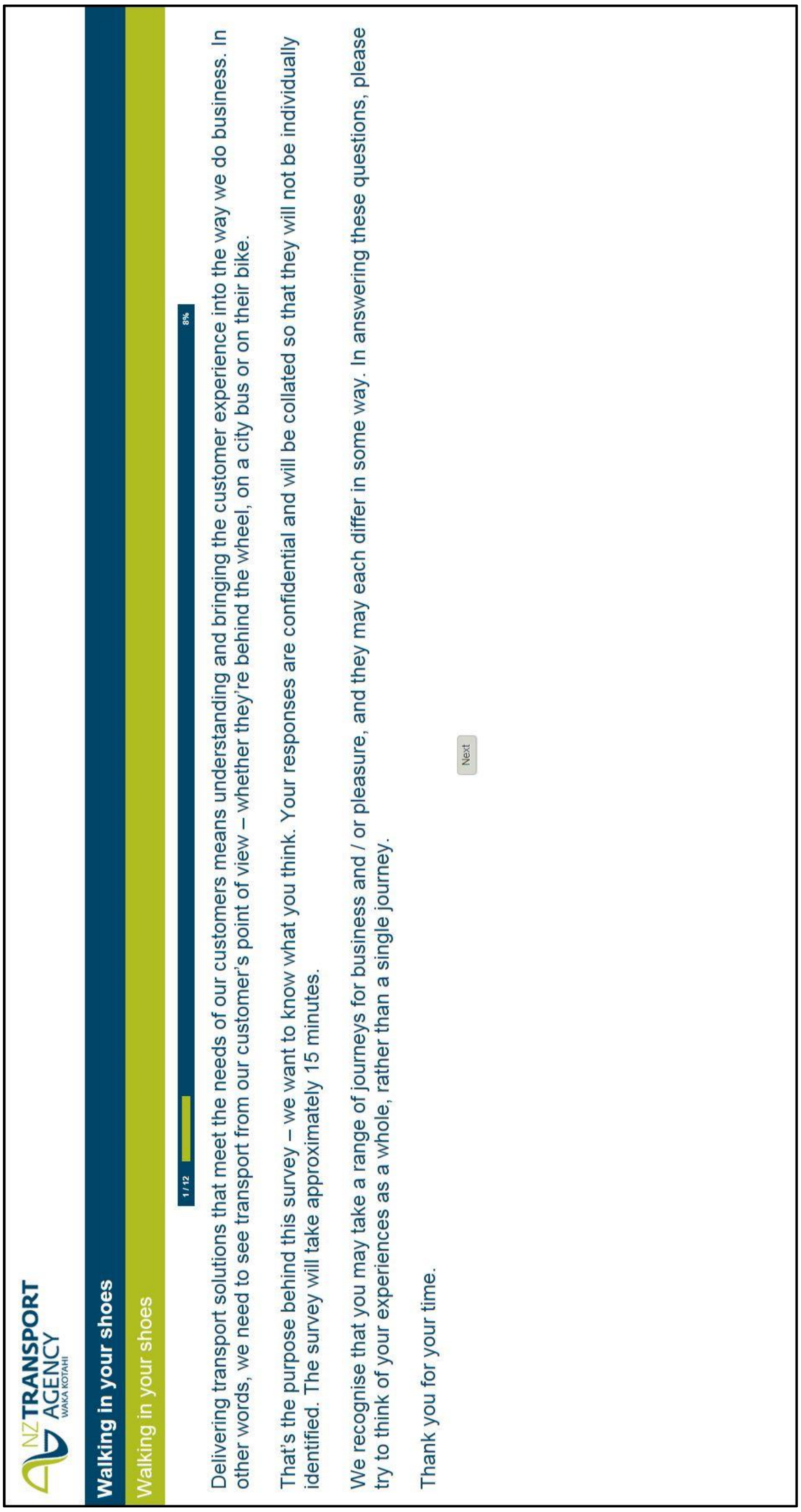
Rather than just looking at the network as map of clustered relationships or tasks, the workshop material was then re-analysed using the tools within Gephi to assess the ‘betweeness centrality’ (or influence) of the six problem dimensions. The aim was to explore in more detail whether this different approach gave a different insight into system leverage.

In this instance, and in contrast with the data presented in Figure AVIII.20, outright ‘needs’ and the related ‘processes’ were the most dominant areas. However, whilst the source type ‘aptitudes’ had the lowest overall influence as a group, it ranked proportionally higher on average. This suggests that whilst the ‘needs’- and ‘process’-related areas will be important, there will be certain secondary areas that, due to their disproportionate influence, will need to be addressed if change is to be effective.

Secondary areas, such as ‘aptitudes’, included the less tangible actions or issues. As such, these may not be immediately obvious or could be easily overlooked when prioritising actions or a change in direction. This suggests that there is merit in this approach as a tool for assessing or testing what to prioritise or leverage when approaching such a complex matter. That is, provided the need to iterate over time is recognised.

APPENDIX IX: DETAILED STUDY 3 QUESTIONNAIRE

Source: NZTA (2014b)



NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

Walking in your shoes

1 / 12 8%

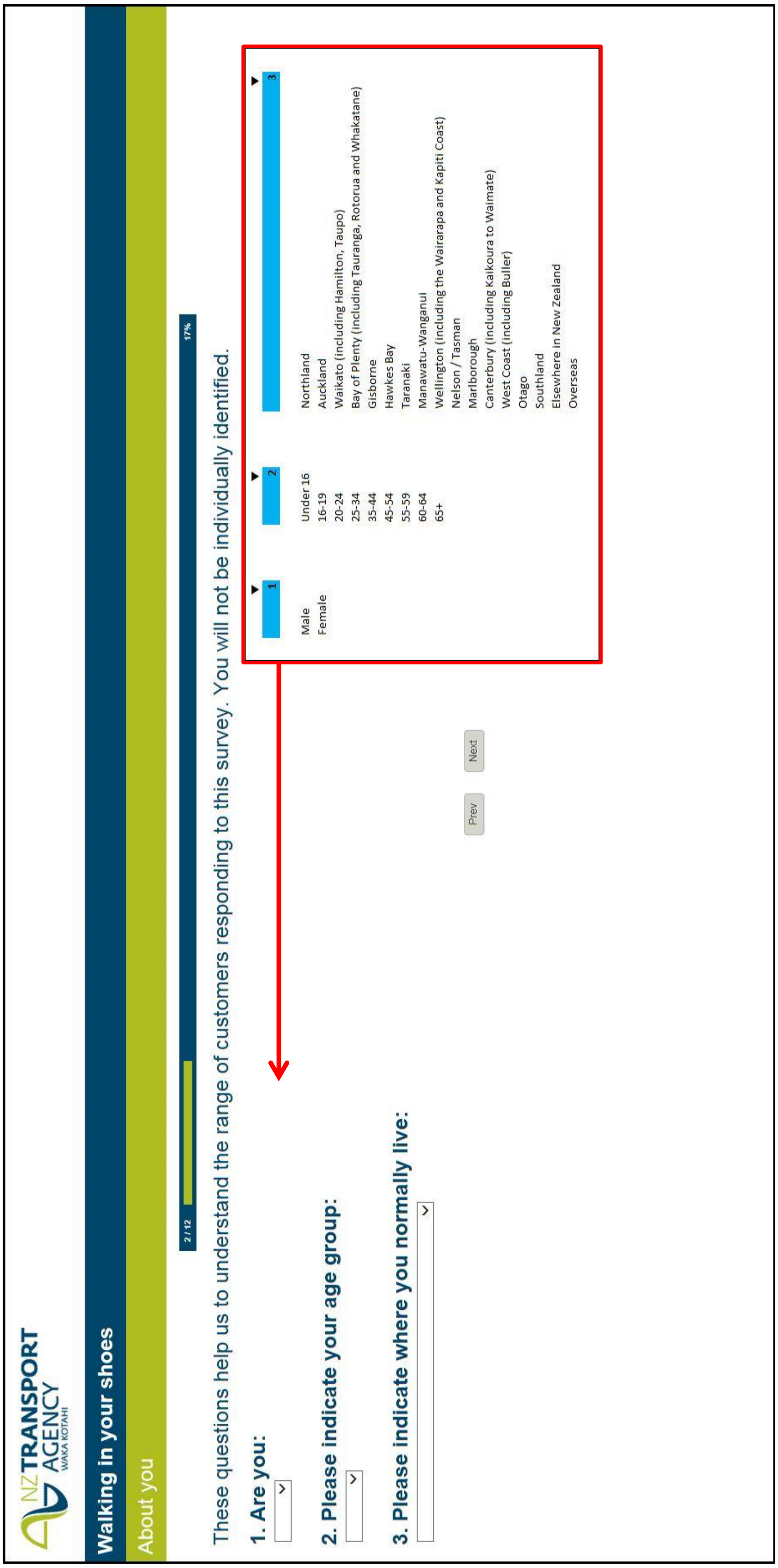
Delivering transport solutions that meet the needs of our customers means understanding and bringing the customer experience into the way we do business. In other words, we need to see transport from our customer's point of view – whether they're behind the wheel, on a city bus or on their bike.

That's the purpose behind this survey – we want to know what you think. Your responses are confidential and will be collated so that they will not be individually identified. The survey will take approximately 15 minutes.

We recognise that you may take a range of journeys for business and / or pleasure, and they may each differ in some way. In answering these questions, please try to think of your experiences as a whole, rather than a single journey.

Thank you for your time.

Next


NZ TRANSPORT AGENCY
WAKA KOTAHI
Walking in your shoes
About you
2 / 12
17%
These questions help us to understand the range of customers responding to this survey. You will not be individually identified.
1. Are you:
2. Please indicate your age group:
3. Please indicate where you normally live:
Prev
Next
1
Male
Female
2
Under 16
16-19
20-24
25-34
35-44
45-54
55-59
60-64
65+
3
Northland
Auckland
Waikato (including Hamilton, Taupo)
Bay of Plenty (including Tauranga, Rotorua and Whakatane)
Gisborne
Hawkes Bay
Taranaki
Manawatu-Wanganui
Wellington (including the Wairarapa and Kapiti Coast)
Nelson / Tasman
Marlborough
Canterbury (including Kaikoura to Waimate)
West Coast (including Buller)
Otago
Southland
Elsewhere in New Zealand
Overseas

NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

How you travel

3 / 12 25%

Roads can include the main roads between towns and cities, including motorways, as well as local roads such as residential streets and rural roads. Footpaths may include paved paths or walkways alongside a road.

4. Please indicate what forms of transport you currently use to travel on roads or footpaths: (You may tick more than one)

- ☐ Car driver
- ☐ Car passenger
- ☐ Light commercial vehicle
- ☐ Truck
- ☐ Bus driver
- ☐ Bus passenger
- ☐ Motorcyclist /scooter
- ☐ Cyclist
- ☐ Pedestrian
- ☐ Pedestrian with pram or pushchair
- ☐ Wheel chair or mobility scooter
- ☐ Segway
- ☐ Horse
- ☐ Skateboard / long board / push scooter
- ☐ Not applicable

Other (please specify)

Prev Next

NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

How you would like to travel

4 / 12 33%

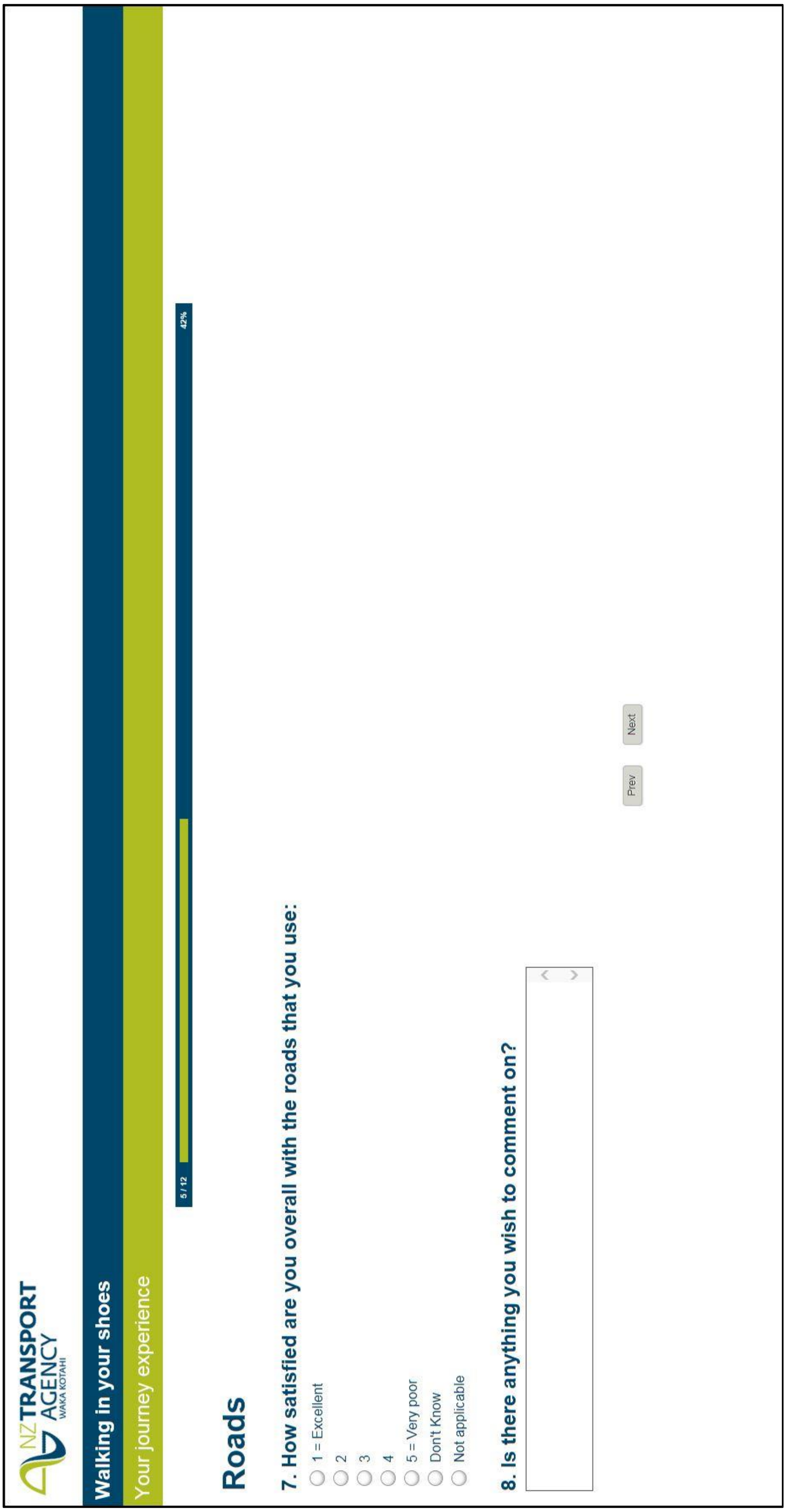
There may be a range of travel options that you would like to use but do not use currently.

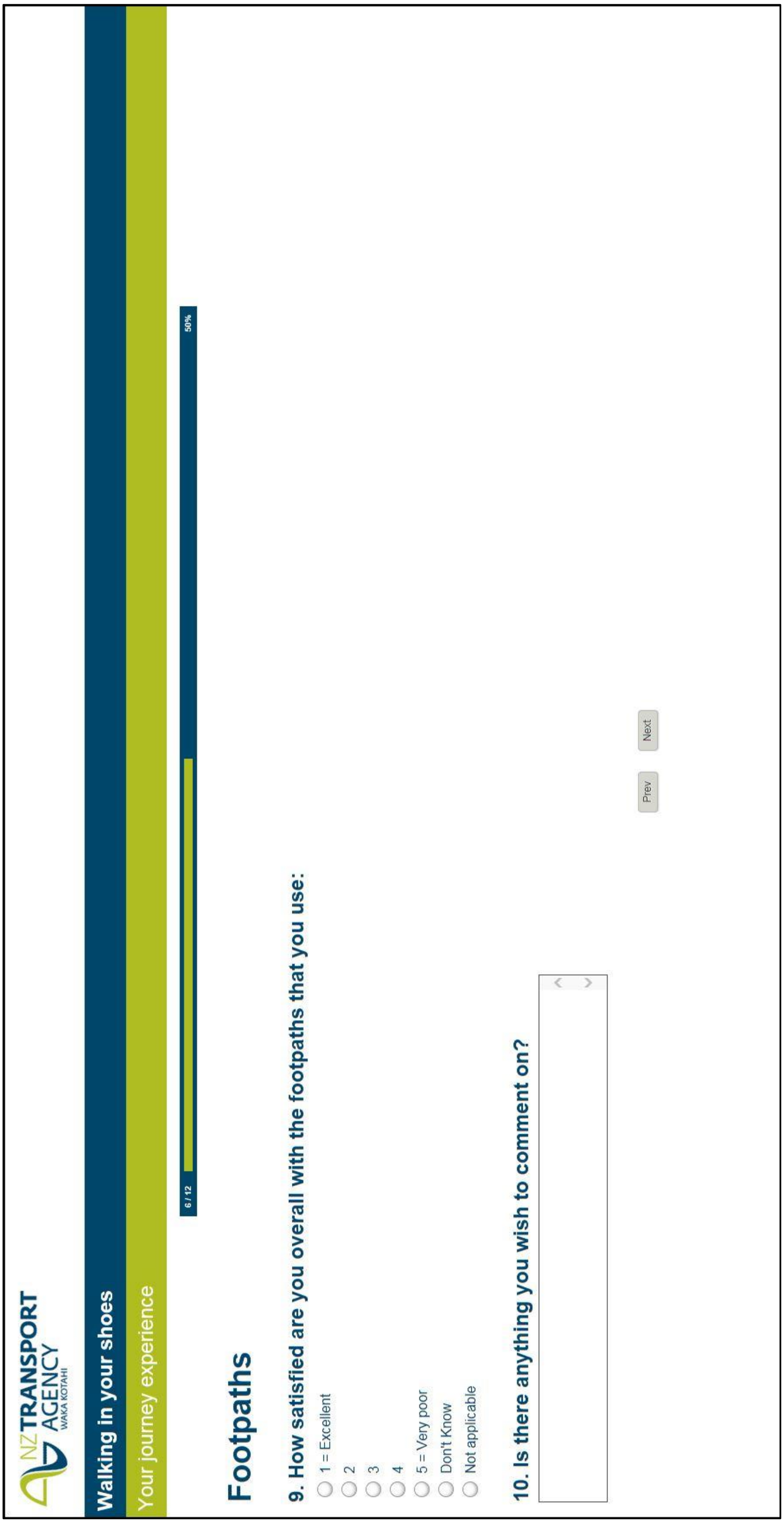
5. Please indicate what forms of transport you would like to use to travel, but do not do so currently:

- ☐ Car driver
- ☐ Car passenger
- ☐ Light commercial vehicle
- ☐ Truck
- ☐ Bus driver
- ☐ Bus passenger
- ☐ Motorcyclist /scooter
- ☐ Cyclist
- ☐ Pedestrian
- ☐ Pedestrian with pram or pushchair
- ☐ Wheel chair or mobility scooter
- ☐ Segway
- ☐ Horse
- ☐ Skateboard / long board / push scooter

Other (please specify)

6. If you have indicated that you would like to use another mode, what factors affect your ability to do so?


NZ TRANSPORT AGENCY
WAKA KOTAHI
Walking in your shoes
Your journey experience
5 / 12
42%
Roads
7. How satisfied are you overall with the roads that you use:
1 = Excellent
2
3
4
5 = Very poor
Don't Know
Not applicable
8. Is there anything you wish to comment on?
Prev
Next


NZ TRANSPORT AGENCY
WAKA KOTAHI
Walking in your shoes
Your journey experience
6 / 12
50%
Footpaths
9. How satisfied are you overall with the footpaths that you use:
1 = Excellent
2
3
4
5 = Very poor
Don't Know
Not applicable
10. Is there anything you wish to comment on?
Prev
Next

NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

Your journey experience

7 / 12 58%

Overall

11. In relation to both roads and footpaths, and your overall journey experience, please rank the following in order of importance to you. *(1= most important, 12 = least important)*

- Accessibility
- Comfort
- Connectivity
- Convenience
- Cost
- Environmental outcomes
- Information
- Interesting / scenic
- Options
- Reliability
- Safety
- Travel time


NZ TRANSPORT AGENCY WAKA KOTAHI

Walking in your shoes

Travel comfort

8 / 12 67%

Overall

12. Thinking about your journey experiences, how would you rate your journey comfort when you are travelling as:

	1=Excellent	2	3	4	5=Very poor	Don't know
Bus driver	○	○	○	○	○	○
Bus passenger	○	○	○	○	○	○
Cyclist	○	○	○	○	○	○
Car driver	○	○	○	○	○	○
Car passenger	○	○	○	○	○	○
Horse rider	○	○	○	○	○	○
Light commercial vehicle	○	○	○	○	○	○
Motorcyclist /scooter	○	○	○	○	○	○
Pedestrian	○	○	○	○	○	○
Pedestrian with pram or pushchair	○	○	○	○	○	○
Segway rider	○	○	○	○	○	○
Skateboard / long board / push scooter	○	○	○	○	○	○
Truck driver	○	○	○	○	○	○
Wheel chair or mobility scooter	○	○	○	○	○	○
Not applicable	○	○	○	○	○	○

Prev Next

NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

Travel comfort

Road users only

13. What factors affect your comfort?

	Car driver	Car passenger	Cyclist	Motorcyclist /scooter	Light commercial vehicle	Truck	Bus driver	Bus passenger
Not applicable	☐	☐	☐	☐	☐	☐	☐	☐
Appropriate speeds	☐	☐	☐	☐	☐	☐	☐	☐
Clear and logical information	☐	☐	☐	☐	☐	☐	☐	☐
Consistency and predictability	☐	☐	☐	☐	☐	☐	☐	☐
Connectivity and accessibility	☐	☐	☐	☐	☐	☐	☐	☐
Distractions	☐	☐	☐	☐	☐	☐	☐	☐
Freedom, flexibility and choice	☐	☐	☐	☐	☐	☐	☐	☐
Good shoulders / ability to pull over	☐	☐	☐	☐	☐	☐	☐	☐
Lighting	☐	☐	☐	☐	☐	☐	☐	☐
Narrow spaces	☐	☐	☐	☐	☐	☐	☐	☐
Vehicle condition	☐	☐	☐	☐	☐	☐	☐	☐
Safety issues	☐	☐	☐	☐	☐	☐	☐	☐
Other's behaviour	☐	☐	☐	☐	☐	☐	☐	☐
Potholes	☐	☐	☐	☐	☐	☐	☐	☐
Pleasant surroundings	☐	☐	☐	☐	☐	☐	☐	☐
Road surface texture	☐	☐	☐	☐	☐	☐	☐	☐
Road roughness and defects	☐	☐	☐	☐	☐	☐	☐	☐
Rest areas	☐	☐	☐	☐	☐	☐	☐	☐
Slippery surfaces	☐	☐	☐	☐	☐	☐	☐	☐
Traffic conditions	☐	☐	☐	☐	☐	☐	☐	☐
Time and other pressures, stress	☐	☐	☐	☐	☐	☐	☐	☐
Vision and visibility	☐	☐	☐	☐	☐	☐	☐	☐
Weather / environmental factors	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

14. If you indicated that there were other factors important to your comfort on the road, please tell us about these.

NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

Travel comfort

10 / 12 83%

Road users only

15. Of the comfort factors you identified, please rank the three that are most important to you. *(1= most important, 3 = least important)*

	1	2	3
Appropriate speeds	○	○	○
Clear and logical information	○	○	○
Consistency and predictability	○	○	○
Connectivity and accessibility	○	○	○
Distractions	○	○	○
Freedom, flexibility and choice	○	○	○
Good shoulders / ability to pull over	○	○	○
Lighting	○	○	○
Narrow spaces	○	○	○
Other's behaviour	○	○	○
Pleasant surroundings	○	○	○
Potholes	○	○	○
Rest areas	○	○	○
Road surface texture	○	○	○
Road roughness and defects	○	○	○
Safety issues	○	○	○
Stress	○	○	○
Slippery surfaces	○	○	○
Time and other pressures	○	○	○
Traffic conditions	○	○	○
Vehicle condition	○	○	○
Vision and visibility	○	○	○
Weather / environmental factors	○	○	○
Other	○	○	○

16. If you indicated that there were other factors important to your comfort on the road, please tell us about these.

NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

Travel comfort

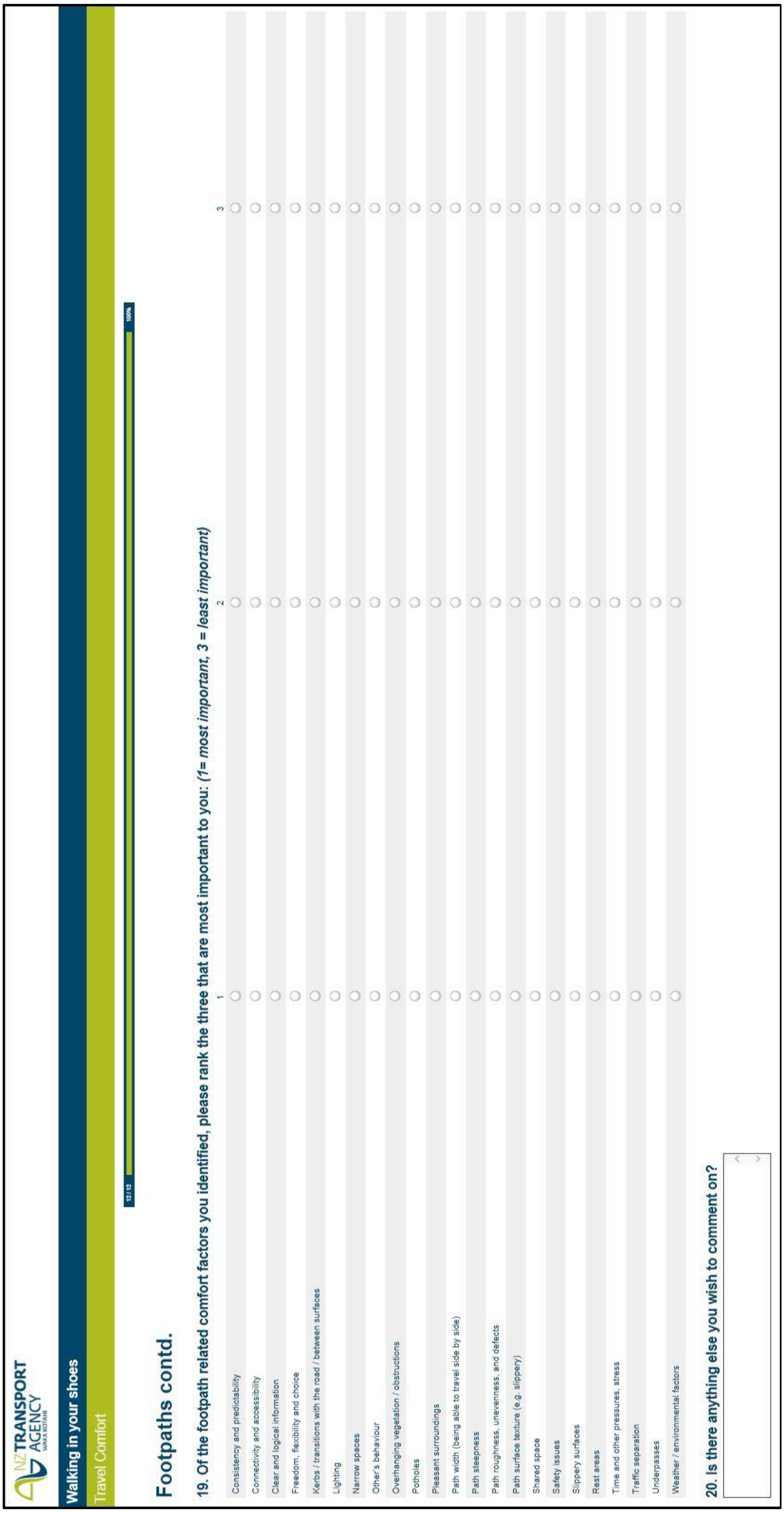
11 / 12 92%

Footpaths

17. What factors affect your comfort on footpaths?

	Bus passenger	Cyclist	Pedestrian	Pedestrian with pram or pushchair	Wheel chair or mobility scooter	Segway	Horse	Skateboard / long board/ push scooter
Not applicable	☐	☐	☐	☐	☐	☐	☐	☐
Consistency and predictability	☐	☐	☐	☐	☐	☐	☐	☐
Connectivity and accessibility	☐	☐	☐	☐	☐	☐	☐	☐
Clear and logical information	☐	☐	☐	☐	☐	☐	☐	☐
Freedom, flexibility and choice	☐	☐	☐	☐	☐	☐	☐	☐
Kerbs / transitions with the road / between surfaces	☐	☐	☐	☐	☐	☐	☐	☐
Lighting	☐	☐	☐	☐	☐	☐	☐	☐
Narrow spaces	☐	☐	☐	☐	☐	☐	☐	☐
Other's behaviour	☐	☐	☐	☐	☐	☐	☐	☐
Overhanging vegetation / obstructions	☐	☐	☐	☐	☐	☐	☐	☐
Potholes	☐	☐	☐	☐	☐	☐	☐	☐
Pleasant surroundings	☐	☐	☐	☐	☐	☐	☐	☐
Path width (being able to travel side by side)	☐	☐	☐	☐	☐	☐	☐	☐
Path steepness	☐	☐	☐	☐	☐	☐	☐	☐
Path roughness, unevenness, and defects	☐	☐	☐	☐	☐	☐	☐	☐
Path surface texture (e.g. slippery)	☐	☐	☐	☐	☐	☐	☐	☐
Shared space	☐	☐	☐	☐	☐	☐	☐	☐
Safety issues	☐	☐	☐	☐	☐	☐	☐	☐
Slippery surfaces	☐	☐	☐	☐	☐	☐	☐	☐
Rest areas	☐	☐	☐	☐	☐	☐	☐	☐
Time and other pressures, stress	☐	☐	☐	☐	☐	☐	☐	☐
Traffic separation	☐	☐	☐	☐	☐	☐	☐	☐
Underpasses	☐	☐	☐	☐	☐	☐	☐	☐
Weather / environmental factors	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐

18. If you indicated that there were other factors important to your comfort on the road, please tell us about these.



NZ TRANSPORT AGENCY WAKA KOTAHI

Walking in your shoes

Travel Comfort

12 / 12 100%

Footpaths contd.

19. Of the footpath related comfort factors you identified, please rank the three that are most important to you: ***(1= most important, 3 = least important)***

	1	2	3
Consistency and predictability	○	○	○
Connectivity and accessibility	○	○	○
Clear and logical information	○	○	○
Freedom, flexibility and choice	○	○	○
Kerbs / transitions with the road / between surfaces	○	○	○
Lighting	○	○	○
Narrow spaces	○	○	○
Other's behaviour	○	○	○
Overhanging vegetation / obstructions	○	○	○
Potholes	○	○	○
Pleasant surroundings	○	○	○
Path width (being able to travel side by side)	○	○	○
Path steepness	○	○	○
Path roughness, unevenness, and defects	○	○	○
Path surface texture (e.g. slippery)	○	○	○
Shared space	○	○	○
Safety issues	○	○	○
Slippery surfaces	○	○	○
Rest areas	○	○	○
Time and other pressures, stress	○	○	○
Traffic separation	○	○	○
Underpasses	○	○	○
Weather / environmental factors	○	○	○

20. Is there anything else you wish to comment on?

NZ TRANSPORT AGENCY
WAKA KOTAHI

Walking in your shoes

Thank you for completing our survey!

Done