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Measuring infrastructure asset performance and customer satisfaction: a review of existing frameworks

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Foreword

Well-managed, modern and functioning infrastructure underpins much of Australia's economic prosperity. Services provided by roads, rail, ports, telecommunications networks and energy infrastructure are essential inputs into the activities of most Australian businesses. Infrastructure performance therefore has implications beyond the infrastructure sector. Yet current infrastructure performance measures often reflect the priorities of infrastructure owners and/or operators rather than those of customers, and therefore may overlook the changing needs of customers.

The Better Infrastructure Initiative (BII) at the John Grill Centre for Project Leadership (University of Sydney) are undertaking research focussed around how to manage Australia's infrastructure assets for long-term efficiency gains. This report, prepared with input from the BII, provides a review of existing infrastructure performance measures and performance measurement frameworks in Australia and elsewhere, and how customer preferences might be better incorporated to improve the long-term efficiency of operation of Australia's infrastructure assets.

This report was prepared by James Wilson, under the broad direction of David Mitchell.

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At a glance

- Over the past several decades, Australia has corporatised or privatised many of its major infrastructure assets—including telecommunications networks, electricity assets, airports, railways and major ports—and relied increasingly on the private sector for procurement of new infrastructure.
- Private sector involvement in infrastructure has delivered considerable economic benefits, through improved productivity, reduced costs to consumers and delivery of projects at a lower cost.
- However, many infrastructure markets are characterised by high fixed (sunk) costs and low marginal costs, and hence naturally disposed to one or few suppliers, which can lead to less efficient market outcomes.
- While not a direct substitute for competition or appropriate regulation, customer performance measures can be used to provide a form of accountability for infrastructure operators' performance, especially where competition is limited.
- This report presents a consistent and general framework for comparing performance across different infrastructure asset types, combining objective performance measures with customer satisfaction survey results, across various infrastructure performance aspects—reliability, amenity, price, safety, availability and timeliness.
- The framework can be applied across infrastructure asset types, and allows customers to easily identify which operators are performing well, and in which areas.
- The infrastructure performance and customer satisfaction framework is a first step towards presenting clearer information on infrastructure performance to customers, and may be a way to prompt infrastructure operators, governments and policy makers to think more critically about the needs and priorities of the users of Australia's infrastructure.

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Executive summary

Well-managed, modern and functioning infrastructure underpins much of the economic prosperity of Australia. Assets such as roads, rail, ports, telecommunications networks and energy infrastructure are more or less essential to the activities of all other Australian businesses. It is thus crucial that Australia's infrastructure keeps up with the needs of the community.

In 2015–16, the total value of major infrastructure engineering construction work done in Australia exceeded $45 billion (ABS, 2016). Such headline statistics, however, ignore the fact that much of Australia's infrastructure has already been built, and that additional economic gains from such infrastructure will be obtained from its efficient management, operation and use.

Given the importance of infrastructure assets to upstream and downstream businesses, it is understandable that significant attention be paid to how they are performing. In the past, public ownership provided institutional mechanisms to monitor the performance of economic infrastructure, such as public entity reporting requirements and responsible government. However, increased private provision and ownership of Australian infrastructure means the issue of infrastructure performance measurement and customer satisfaction has taken on renewed importance in Australia. In many cases, there is little or no requirement for private operators to collect performance data that can be used to hold them accountable to the public or to their shareholders. In even fewer circumstances has data been used to incentivise private owners to respond to the needs of their customers.

While some infrastructure asset types, namely public roads and airports, have made significant progress in performance measurement, for others there is a dearth of information or public engagement. A broader problem, affecting even public roads and airports, is that performance measurement to date has reflected the priorities of infrastructure operators, rather than those of customers. Where data is available, it is highly technical, and/or not easily accessible.

The patchwork approach that has resulted means that Australia may be missing out on the potential benefits of consistent and widespread performance measurement: improved accountability, incentivised performance, and better performance evaluation.

Measuring customer satisfaction

The academic literature has explored the issue of infrastructure performance and customer satisfaction for several decades, most notably in the public transport sector, largely because of efforts by public transport agencies to measure their performance and their willingness to work with academics.

The substantive debate has generally focussed on the use of *objective,* data-driven performance measures and *subjective,* mainly survey-based measures of customer satisfaction. Much of the early focus was on using subjective measures to rate infrastructure performance; the argument being that customers, as the final end users of infrastructure, are best placed to rate performance.

In recent years, the consensus has moved towards the position that objective and subjective measures are equally important to developing a holistic picture of the performance of infrastructure assets. This is because while customers are best placed to rate their satisfaction with infrastructure asset performance, many factors important to the service quality experienced by customers (for example, the strength of road pavement) are typically 'invisible' to customers, and may only become significant once a defect has occurred.

To this end, academics have sought to develop models that combine the two in various ways. Recent research has sought to combine an objective indicator (for example, of road surface quality) with a subjective indicator measuring the same attribute (for example, a survey of road user perception of road surface quality) into a single metric that more heavily weights the subjective indicator when customer opinion is more uniform.

Several problems, however, remain with the use of customer surveys in monitoring the long-term performance of infrastructure assets. Notably, survey respondents often exhibit *recency bias*, whereby changes in perceived performance are based more on recent experience, rather than historical experience. This is a problem given that most infrastructure assets have a lifespan of several decades; any improvement in service quality may be gradual over that length of time. Other problems include the reliability of surveys over time. Intertemporal customer satisfaction data appears to be highly unreliable, with a recent study finding that survey respondents' perception of the change in service quality across periods only coincided with their stated satisfaction ratings 40 per cent of the time (Becker and Albers, 2016, p. 835).

Several techniques have been explored in the literature to correct these problems, including regression analysis, and structural equation modelling (SEM). However, there is little agreement as to which method is most accurate.

Infrastructure performance measures in Australia and internationally

Broadly, performance measures appear more comprehensive and more readily available for publicly-owned or publicly-regulated infrastructure (for example, roads and airports). Far less performance information appears to be available for privately-owned and unregulated infrastructure assets.

Several state and territory road agencies have comprehensive performance measurement frameworks in place, while others are moving in this direction. The degree to which they are implemented and publicly reported varies across jurisdictions. Most states and territories survey road users on their satisfaction with the road network, but such surveys are generally high level and only ask about overall satisfaction, rather than satisfaction with more specific aspects of service quality.

Private sector infrastructure investment and performance measurement

The privatisation of infrastructure assets and the use of PPPs to build new assets has had consequences for the measurement of infrastructure performance.

While privatisation and PPPs have generally delivered benefits for the Australian economy and consumers, they do not automatically lead to the most efficient outcomes for consumers or business users, particularly in markets with opportunities for monopolistic behaviour by private operators. In fact, several case studies show that state governments have provided private operators with concessions designed to reduce the upfront cost of PPPs, or raise the sale price of assets, which have had potentially negative long-term impacts on customers and economic efficiency. Frequently, little attention is given to measuring the performance of assets pre- and post-construction/privatisation, making evaluation of their success, or otherwise, difficult.

While adequate provision for performance data collection would be desirable for future projects and privatisation, it is not a direct substitute for adequate economic regulation of monopolies.

New forms of performance measurement (economic regulation), however, are starting to emerge. A case study of New Zealand's first road PPP shows that it is possible for governments to link the performance of a private operator in operating an asset to the payments they receive for doing so—that is, an *outcomes*-based approach rather than a traditional *outputs*-based approach. While the success of this approach is not yet assessable (construction on the road is not yet complete), it represents an alternative avenue that governments can take to incentivise private operators to act in the best interest of their customers, noting that this model may not be suitable in all circumstances.

Towards a framework for measuring infrastructure performance

Based on this research, BITRE presents a consistent and general framework for comparing performance, incorporating customer satisfaction, across different infrastructure asset types.

The infrastructure performance and customer satisfaction framework is a methodology which combines objective measures of infrastructure performance and customer satisfaction survey results into one score for each of seven service quality attributes—reliability, amenity, price, safety, availability, timeliness, and information—and two output measures—capacity and activity.

The framework can be applied across infrastructure asset types, and allows customers to easily identify which operators are performing well, and in which areas. Its strength is in its flexibility for operators in implementation, and simplicity for customer in interpretation. The framework does not replace existing performance measurement frameworks, but is reliant on infrastructure operators changing their internal processes where necessary to collect relevant performance and customer satisfaction data should they wish to implement it.

The infrastructure performance and customer satisfaction framework is a first step towards presenting clearer information on infrastructure performance to customers, and may be a way to prompt infrastructure operators, governments and policy makers to think more critically about the needs and priorities of the users of Australia's infrastructure.

CHAPTER 1
Introduction

1.1 Introduction

For most of Australia's European history, Australian governments have played a major role in the planning, development, construction and ongoing operation of the country's infrastructure assets. Early on in the nation's development, governments were the only institutions capable of taking on the risks and high fixed costs associated with such large investments. Many of these infrastructure assets exhibited public good characteristics, limiting commercial prospects, and many were "nation-building" projects, aiding the development of commercial opportunities that benefited from the availability of infrastructure. Indeed, Australia "pioneered the use of public enterprises for developmental purposes" during the 1800s (Gray, 2009, p. 7). Early examples include the construction of Australia's state rail networks in the 1860s, and ports throughout the 19th Century.

Over the past three decades, much of Australia's public infrastructure and infrastructure-related businesses, such as airlines, railways and telecommunications service providers, have been privatised; although pockets remain, most notably the public road network. Many of these initiatives followed broader market deregulation—for example, the sale of Qantas and Australian Airlines followed deregulation of domestic aviation in 1989.

Around the same time, financial deregulation, the globalisation of capital markets and the build-up of national savings through superannuation opened up significant pools of capital in search of long-term investments to match the maturities of their liabilities. Infrastructure was a natural destination for some of these funds, and since the 1980s an increasing number of projects have been financed with private capital through Public-Private Partnerships (PPPs).[1]

Australia's experience with infrastructure privatisation and privately-built projects has generally been positive (PC, 2014, p. 7). There have, however, been some notable projects that have failed to achieve their stated aims, or which have run into financial difficulties. More recently, there have been concerns raised about the long-term benefits of some high-profile privatisations, and some governments' perceived focus on revenue objectives (Sims, 2016 cited in Potter, 2016). Australians also appear to be questioning the merits of PPPs and privatisations. One poll in 2015 found that 72 per cent of respondents agreed with the statement, "Utilities like water and power suppliers are too important to be sold off", and 70 per cent agreed with the statements, "Privatisation mainly benefits the corporate sector", and "Prices always increase more when services are privatised" (Essential Media, 2015).

1 BITRE (2017) provides a list of most major transport- and infrastructure-related privatisations and PPPs over the last 30–40 years.

This points to a need for Australian, and state and territory governments to both improve the way they procure infrastructure, and to improve the performance of existing infrastructure assets. A significant barrier to this is the dearth of consistent and uniform performance reporting, especially of infrastructure assets that are distant from customers' day-to-day experience, such as electricity distribution and transmission. Customers lack readily available, easy to interpret measures of how well infrastructure assets are performing. Currently available information is either highly technical, buried in lengthy reports, or both. Sometimes, information is not available at all, as with toll roads. Some organisations (public road agencies, most notably) have made significant progress towards developing more holistic frameworks for measuring the performance of their assets, but implementation is patchy, at best. Given the monopoly characteristics of many infrastructure markets, improved accountability through performance measurement would benefit both customers and shareholders of Australia's infrastructure assets.

This report introduces and explores many of the issues surrounding infrastructure performance measurement that should be considered in the context of providing greater consistency across infrastructure asset types. Many questions remain unanswered, and are specific to particular assets or to the shape of any future project to create a uniform performance reporting framework. This report is intended to provide the basis on which these questions can be answered.

1.2 Measuring infrastructure performance

The rigour with which infrastructure performance is measured in Australia appears most typically correlated with the level of government involvement with the asset type, and the degree of direct consumer interaction. For example, while most state and territory road agencies have some form of public-facing performance measurement framework for the roads under their control, port authorities and toll road companies do not.

Some road agencies have aligned their performance measurement frameworks with contract conditions. For example, NSW Roads and Maritimes Services' (RMS) Stewardship Maintenance Contracts (the state's road maintenance contracts) have performance criteria that must be maintained on risk of payments to the contractor being reduced. Similarly, Melbourne's train and tram franchises are subject to monthly, quarterly and annual reporting requirements, performance against which was considered when the franchises were re-tendered in 2008.

There are, however, significant limitations to current practice. A review of both in-use performance measurement frameworks and the academic literature reveals that there is no agreed upon process for choosing which metrics should be included in a performance measurement framework for a particular infrastructure asset type, let alone across asset types. One of the main conclusions from this review is that there is no "perfect" set of infrastructure performance measures. Existing methods all involve trade-offs that would need to be considered by any company or agency that wishes to implement them. Probably the most problematic is the trade-off between statistical rigour and ease of implementation. There are a plethora of econometric tools that in one way or another correct for various statistical errors in the way performance is measured, but all are complex, and may be impractical to implement. Another ongoing debate centres on the validity of using *subjective* performance measures, such as customer satisfaction surveys, in place of, or in addition to, *objective,* data-driven performance measures.

An additional concern is that performance measurement is only useful insofar as it can lead to operational changes that improve the service for customers. Many PPPs agreed over the past two decades in Australia either discourage infrastructure operators from improving the performance of their assets for customers, or do not allow them to do so without lengthy and costly contract renegotiations.

1.3 The need for a more consistent approach

The renewed focus on measuring infrastructure performance and consumer outcomes in private infrastructure investment has been driven by several factors.

First, performance measurement is patchy in some infrastructure sectors. Performance measurement is well entrenched in sectors such as telecommunications and airports, partly as a result of legislative requirements introduced around the time of the privatisation of Australian Government assets. Other sectors involve collaboration between public and private sector entities, for example, BITRE's (2016a) *Waterline* series, which involves public sector reporting of private sector stevedore performance across Australia's five largest container ports. Many infrastructure assets, however, do not have consumer-friendly, comprehensive performance data, including major assets such as electricity and gas networks, and toll roads. Consumers, who pay directly for these services, continue to remain uninformed of how efficiently or effectively these assets operate.

Public roads are subject to a different problem, in that performance frameworks exist but vary widely between states and territories. A recent Austroads (2016) project developed a performance reporting framework for roads, but implementation of the standard may be easier for some jurisdictions than others.

An infrastructure performance and customer satisfaction framework that applies across infrastructure asset types would make operators accountable to consumers and shareholders, and allow for some form of comparison across asset types.

Second, existing performance measurement frameworks lack a whole-of-life approach to asset performance. The conditions under which an asset is procured through a PPP, or sold through privatisation, can have a significant impact on whether, and/or to what extent, benefits are fully realised. The importance of this fact was acknowledged by the Australian Competition and Consumer Commission (ACCC) (2014a, p. 35) which observed with concern that,

> *"Australian governments are focusing overly on short term budget goals without sufficient regard to longer term competition… Such short term financial benefits amount to a tax of future generations of Australians."*

As alluded to by this statement, a focus on financial considerations inevitably comes at the expense of economic efficiency over the decades-long life of most infrastructure assets. In the most egregious examples, infrastructure has been procured with conditions that "undermined the legitimacy" of projects in the eyes of the public (Grimsey and Lewis, 2007, p. 179). For example, in an effort to reduce their impact on budgets, many state governments created toll road PPPs in the 2000s that transferred patronage (and thus funding) risk onto private-sector operators, and then agreed to close alternate routes in an attempt to shift traffic onto the new toll roads. Not only does this practice raise the ire of motorists, it reduces the capacity and efficiency of the wider road network in direct contradiction to the reasons for building new

roads in the first place. In addition, many road PPP contracts were written without incentives for road operators or state road agencies to improve the asset over a contract's life, a shortcoming "keenly felt by motorists and the community today" (Bowditch et al., 2016, p. 24).

These decisions have long-term consequences for asset performance, and for wider network performance. An asset may be performing well on many measures, but poor contractual terms may mean that it is not performing as well as it could be. In a road network, for example, an asset may have high patronage and good performance metrics, but these may be achieved at the expense of broader network efficiency. In these situations, a performance framework, created after the fact, may be compromised from the outset. For new infrastructure to deliver the greatest benefit to Australians,

> *"Privatisation [and PPPs] should be subject to appropriate processes to ensure that the public interest is protected through structural separation, regulation, sale conditions and community service obligations" (PC, 2014, p. 41).*

A final factor driving the re-examination of infrastructure performance measurement is that privatisations, PPPs, and existing performance measurement frameworks frequently focus on the relationship between the state and the private provider, with little explicit consideration of the needs of customers (Mokonyama and Venter, 2013, p. 59). As mentioned previously, private investment has at times focused more on reducing the costs to government of procuring infrastructure, or on raising the sale price of existing infrastructure, than on the current and future needs of customers. Many asset performance frameworks and KPIs have been developed without significant input from the public, with the result being that performance measures focus on the relevant government agency or asset owner's perspective, rather than that of their customers. This mainly manifests in performance indicators that measure inputs and outputs, rather than outcomes for customers. For example, port productivity can be measured in several ways, but it is unclear if these are particularly relevant to businesses shipping goods by sea. These businesses may only be interested in how long their goods are waiting in port to be loaded onto a container ship, which is a broader question than can be answered with the current port productivity indicators. A uniform performance measurement framework must ensure that consumer preferences and priorities are reflected in what is being measured.

Infrastructure Australia (2016, pp. 164–165) acknowledged these factors in its 2016 *Australian Infrastructure Plan,* calling for "a national approach to infrastructure performance measurement across our infrastructure sectors… focussing on the measurement of outcomes."

1.4 Report structure

Chapter 2 provides an overview of the academic literature regarding the measurement of both customer satisfaction and infrastructure performance, including how the two can be used together. Chapter 3 considers case studies of current best practice, both in Australia and internationally. Chapter 4 reviews some recent infrastructure privatisation and PPP infrastructure projects and explores the scope for including performance measures at an early stage of each process. Finally, Chapter 5 introduces a potential framework for how customer satisfaction can be incorporated into infrastructure performance measurement across asset types. Several appendices provide additional supporting information.

CHAPTER 2

Measuring customer satisfaction and infrastructure performance

Summary

- Academics have been investigating the issues involved in measuring customer satisfaction and infrastructure service performance for many years.
- The research suggests there is no single performance measurement framework that can perfectly capture both customer perception and service performance over time, across different uses and in different places.
- Despite these issues, it is generally accepted that some attempt at measuring customer satisfaction and/or asset performance is better than no information at all, and that combining customer perception and objective performance data is necessary to best inform service delivery and asset management.

2.1 Introduction

Academics have been grappling with the issues of measuring customer satisfaction and infrastructure performance for the better part of thirty years. Many recent efforts have focused on public transport, probably because data is more readily available and because of a strong public interest in assessing the performance of public sector service provision. This means that many of the references in this chapter in some way refer to customer satisfaction from the perspective of the public transport sector. However, the concepts and techniques used in this literature are readily applicable to other infrastructure asset types.

2.2 How to measure

Challenges begin with what sort of information constitutes a valid measure of customer satisfaction. There are broadly two types of performance data: *objective* performance data, which directly measures the output of assets or activities of the business; and *subjective* performance data, which involves directly measuring customer satisfaction with asset or business performance, for example, through surveys. These are then sometimes grouped into service quality attributes, such as safety, reliability, and availability, depending on what is being measured.

Most infrastructure owners collect some sort of objective data on the performance of their assets over time, but rather than directly measure customer satisfaction, many use objective performance data as an indirect measure of customer satisfaction. RMS (2016, p. 44) groups objective measures of journey time reliability, average incident clearance time, and the percentage of the road network available to Higher Mass Limit (HML) vehicles under the heading of "meeting customer and community needs". The Florida Department of Transportation (2013, p. 25) goes further, explicitly stating that its performance framework is a "quantitative stratification" of customers' satisfaction with the state's highway network.

Frameworks of this type rely on an infrastructure owner/manager's perspective on how well an asset is performing. The Transportation Research Board (TRB) (2003, p. 8) notes that this rests on the assumption that if they do their job well, "there would be no customer or community concerns".

However, according to Eboli and Mazzulla (2011, p. 172) objective performance measures are not an adequate proxy for customer satisfaction:

> *"Passengers evaluate services in many ways that may not be systematically associated with the amount of use of the service, because the measures of efficiency and effectiveness… implicitly assume homogeneity of service quality."*

Many researchers now acknowledge that the customer's perspective should inform measures of service quality, not solely the perspectives of the asset owners/managers (TRB, 2003; Eboli and Mazzulla, 2011).

To this end, much research over the past decade has focussed on customer satisfaction surveys of infrastructure and/or service performance. However, there remains wide variation in how researchers treat many of the factors that influence the outcome and interpretation of surveys: whom to survey, which attributes of an asset to survey and what model of customer satisfaction measurement to use. There are also a variety of methods used to evaluate survey data and deal with survey-specific issues, such as stated preference bias.

2.3 Whom to survey

Anderson, Pearo, and Widener (2008, p. 365) note that researchers and practitioners are interested in customer satisfaction, "in part because studies find that customer satisfaction is an antecedent of increased market share, profitability, positive word of mouth, and customer retention." For this reason, Becker and Albers (2016, p. 831) eliminate "transit captives", who have no choice but to use public transport, from their study, "because the quality perceptions of these respondents do not affect their mode choice," that is, the market share of public transport. For public transport, it may be legitimate to exclude transit captives. After all, customers who are free to avoid public transport if they are unsatisfied determine its market share and profitability, not those with no other options.

But eliminating "captives" raises questions for the many infrastructure asset types for which there is only one provider in any particular region, such as airports and sea ports, and electricity and gas transmission and distribution networks. For these monopoly infrastructure providers, customer satisfaction has a less direct link with profitability, and hence is why such sectors in Australia are usually subject to significant economic regulation or pricing surveillance in place of market competition. A notable exception is airports, which derive revenue from airline

passengers both directly (though aeronautical charges in airline ticket prices) and indirectly. It has been shown that higher passenger satisfaction is associated with higher retail concession revenues, part of which eventually flow to airport owners (J.D. Power and Associates, 2010, p. 1).

A further complication comes from the fact that end users of an infrastructure service may not be the direct customer of the infrastructure provider. For example, retail electricity consumers are the end users of the services provided by three tiers of providers—generators, transmission providers and local distributors. Consumers pay for their services, and do not directly interact with them; yet all three tiers of this market influence their electricity consumption experience. It is unclear, then, if it is appropriate for retail customers to be surveyed about the service quality of generators, transmission companies and local distributors. There is, in fact, no way for a retail customer to judge the quality of service they receive from these upstream providers, or distinguish between the services they provide. By contrast, large industrial users, who buy electricity directly from the National Electricity Market (NEM), without a retail intermediary, may be better placed to make judgements about the service they receive from a distribution company. In these infrastructure sectors, the question is then, whose satisfaction should be surveyed: retail customers' or that of wholesale/intermediary firms?

2.4 What asset attributes to measure

The selection of which attributes of service quality to survey is problematic for several reasons. First, the literature does not discuss which method of attribute selection is most valid. Within the public transport literature, Eboli and Mazzulla (2008, p. 513) presented survey respondents with nine service attributes to rate, while dell'Olio et al. (2010, p. 389) held focus groups and came up with 12 attributes they then surveyed. Mouwen (2015, p. 5) identified 15 attributes arbitrarily divided into "core" and "peripheral." Some researchers, including Tyrinopoulos and Antoniou (2008), chose to base their list of attributes largely on the TRB's (1999) *Handbook for Measuring Customer Satisfaction and Service Quality.* A review of the literature by de Oña and de Oña (2014, p. 5) found that common attributes include:

- frequency of service;
- punctuality;
- comfort and cleanliness;
- safety;
- availability of information;
- personnel courtesy; and
- fares.

However, they also stated that, "other aspects should be considered for each context-specific service," somewhat undermining the idea that a uniform set of attributes across jurisdictions could be developed (de Oña and de Oña, 2014, p. 5).

Table 2.1 highlights this problem by providing a comparison of the service quality attributes of bus networks identified by various authors. This demonstrates that service quality criteria are often developed separately for each new piece of research, rather than working off a standardised set of criteria.

Table 2.1 Service quality attributes for public buses, various authors

Eboli and Mazzulla, 2008	dell'Olio, et al., 2010	Mouwen, 2015	Tyrinopoulos and Antoniou, 2008
• Walking distance to the bus stop	• Waiting time	• On-time performance	• Punctuality
• Frequency	• Journey time	• Travel speed	• Passenger safety
• Reliability	• Access time walking to the initial bus stop	• Service frequency	• Transfer distance
• Bus stop facilities	• Safety within the vehicle	• Prices of the tickets	• Network coverage
• Bus crowding	• Comfort during starting and stopping	• Personnel behaviour	• Vehicle cleanliness
• Cleanliness	• Comfort during journey	• Driver's behaviour	• Driver behaviour
• Fare	• Deviation from the optimal route	• On-board information on delays	• Waiting conditions
• Information	• Cleanliness of the vehicle	• Ticket-selling network	• In-vehicle service conditions
• Transit personnel attitude	• Price of the bus ticket	• Information provision at stops	• Ticketing system
	• Quality of the vehicle	• Safety at stops	• Behaviour of non-driver staff
	• Reliability of the vehicle	• Vehicle tidiness	• Service frequency
	• Kindness of the bus driver	• Ease of boarding and alighting	• Waiting time
		• Seating capacity	• Price
		• On-board noise	• Information about schedule

Source: Eboli and Mazzulla (2008), dell'Olio et al. (2010), Mouwen (2015), Tyrinopoulos and Antoniou (2008).

There exists an additional challenge for the current project: namely, identifying metrics across different infrastructure sectors that measure the same outcomes in a uniform manner. For example, on the NEM, reliability is measured as the percentage of customer demand unserved due to supply shortfalls (AEMC, 2014, p. 6). But is reliability of the electricity grid perceived in the same way as the reliability of airports, or of the road network? It is likely that consumers would react differently and place different values on reliability across different infrastructure asset types. It would be possible to calculate sector-specific reliability measures based off a single monetary value of customer reliability, but to date no research has been done on this topic. Furthermore, the exercise would need to be completed for each attribute selected and across each infrastructure sector.

In addition, for some assets customer satisfaction could be a binary "satisfied" or "unsatisfied" (for example, electricity), while for others it is a continuous or ordered rating (for example, road congestion). For example, customers may rate the reliability of their electricity supply as satisfactory until the power goes out, while their satisfaction with travel time would vary with the level of congestion on the roads they drive. This important distinction would need to be addressed in any consistent infrastructure performance framework.

2.5 Measuring customer satisfaction

de Oña and de Oña (2014, p. 13) identify two broad choices of approach in measuring customer satisfaction. The first is between a performance perception and expectations approach, versus a performance-only perception approach; and the second between disaggregate or aggregate measures. In disaggregate approaches, service attributes are analysed individually, while in aggregate approaches, attributes are combined to create an overall index of customer satisfaction.

Aggregate performance-expectation models of customer satisfaction

This model measures customer satisfaction as the sum of the difference between customers' expectations of a service attribute and their rating of its actual performance. The most well known example is SERVQUAL (from *service quality*) by Parasuraman et al. (1988). SERVQUAL is based on gap theory: the idea that "the difference between consumers' expectations about performance of a general class of service providers and their assessment of the actual performance of a specific firm within that class drives the perception of service quality" (Cronin and Taylor, 1992, p. 55). To measure this expectations-performance gap, SERVQUAL uses five dimensions of service quality broken down into 44 survey questions (22 on perceived performance and 22 on expectations). These were chosen based on calculations from a survey of an original 10 dimensions and 194 survey questions (97 on perceived performance and 22 on expectations). The dimensions are:

- tangibles – physical facilities, equipment and appearance of personnel;
- reliability – ability to perform the promised service dependably and accurately;
- responsiveness – willingness to help customers and provide prompt service;
- assurance – knowledge and courtesy of employees and their ability to inspire trust and confidence; and
- empathy – caring, individualised attention the firm provides its customers (Parasuraman et al., 1988, p. 23).

The intention was for these dimensions and the 44 performance and expectation survey questions to be applicable to all industries, and for the process of narrowing from the original 10 dimensions to be replicable. However, this has not been the case. Subsequent research has shown the SERVQUAL structure to be unreliable (Nyeck et al., 2000). SERVQUAL also does not attempt to weight any of the factors it measures, thus providing little direction (beyond the revealed gap between expectations and performance) for asset owners looking for the most efficient way to improve customer satisfaction. As a result, SERVQUAL also assumes that all attributes are equally important to a customer's overall level of satisfaction.

Aggregate performance-only models of customer satisfaction

Researchers have since moved away from expectations-performance models, to service performance-only models, primarily for two reasons:

1. Customers' judgements on the performance of a service are typically already the result of internal comparisons of the expected and actual level of service (de Oña and de Oña, 2014, p. 11); and
2. "Little if any theoretical or empirical evidence supports the relevance of the expectations-performance gap as a basis for measuring service quality" (Cronin and Taylor, 1992, p. 56).

Cronin and Taylor's (1992) SERVPERF (from *service performance*) model is, in effect, SERVQUAL without the expectations. They showed that SERVPERF explained more of the variation in service quality than did SERVQUAL (Cronin and Taylor, 1992, p. 63). However, curiously, the SERVPERF model weighted by survey respondents' stated importance of the 22 attributes had less explanatory power than the unweighted model (Cronin and Taylor, 1992, p. 63). The authors note that generalisations beyond the four service industries they investigated are tenuous, but do not explain why (Cronin and Taylor, 1992, p. 65).

Eboli and Mazzulla (2009) extended the SERVPERF approach to account for heterogeneity of survey responses by weighting satisfaction and importance scores on the dispersion (in this case, the variance) of individual scores from the mean. The result "allows the attributes characterized by more homogeneous user judgments to be considered more significant" (Eboli and Mazzulla, 2009, p. 29). The logic is that measures for which there is more consensus of opinion can be targeted for improvement by asset owners with more certainty of customer satisfaction improving.

Disaggregate performance-only models of customer satisfaction

Recently, researchers have returned to viewing objective performance measures as useful in forming a more comprehensive picture of the performance of an asset. This is due to a number of reasons:

1. Nathanail (2008, p .55) argues that it is "impossible for a passenger to be able to provide a global performance grade… based on the short experience of the trip he/she might have completed" at the time they are surveyed.
2. A study by Thomas and Rhind (2006) found that passengers' perception of the safety and risk of British trains had only a weak relationship with the actual level of safety and risk.
3. The strong subjectivity of customers' judgements means "considerable statistical errors could occur when respondents are not correctly sampled" or are too heteroskedastic (Eboli and Mazzulla, 2012, p. 5).
4. Friman (2004, p. 49) found that "the satisfaction people experience when using public transport services is influenced by quality improvements only to a limited extent," with respondents reporting less satisfaction and higher frequencies of negative critical incidents after quality improvements were implemented.
5. Intertemporal customer satisfaction data appears to be highly unreliable. A study by Becker and Albers (2016, p. 835) found that survey respondents' perception of the change in service quality across periods only coincided with their stated satisfaction ratings 40 per cent of the time.

Additionally, Zak (2011) argues that while customers are best placed to judge the quality of service they receive, they are not the only stakeholder interested in the proper functioning of transport systems, and thus should not be the only group whose opinions are taken into account.

This is the same argument made by Austroads (2006, p. 16):

> *"Some road defects or conditions are not of concern for the community because they are not directly visible. For example, loss of pavement strength is not an issue to the road users until a severe pavement failure occurs. Similarly, the condition of the drainage system is not 'visible' to the community until the road is flooded."*

Austroads (2006, p. 16) asserts that, for this reason, road agencies should establish intervention criteria for such defects independent of community consultation.

Recognising these shortfalls, Eboli and Mazzulla (2011) developed a metric that combines several objective and subjective measures of asset performance into a single measure for various service quality attributes. The metric "aims to develop an indicator which assumes an intermediate value between the subjective and objective measures of service quality, calculated by considering the bias of the two different measures" (Eboli and Mazzulla, 2011, p. 174). It does this by defining an indicator for each attribute through generalised least squares. The sum of the standard deviations of the subjective and objective indicators is minimised and weighted in inverse proportion to the variance of the errors of the subjective and objective indicators. The result is that when the variance of the subjective indicator is close or equal to zero, the new indicator tends to coincide just with the subjective indicator (Eboli and Mazzulla, 2011, p. 180).

In an application of this methodology, Eboli and Mazzulla (2011, p. 179) found, as previous studies have, that the standard deviation of customer satisfaction rates is quite high, but that the attributes rated most highly had the lowest standard deviation. The model considers this, and corrects and more heavily weights the objective indicators when customer opinion is divided.

The logic underpinning the model is clear: if users rate a service attribute as satisfactory (maybe because they expect this attribute to be of a low standard), but the attribute does not meet the standard set by the asset manager, solely focussing on customer satisfaction may lead the owner to ignore improvements that could attract more customers (Eboli and Mazzulla, 2011, p. 180). Similarly, if users rate a service attribute poorly, but the objective indicator states the attribute is performing well, additional resources may do little to improve customer satisfaction in the attribute; In this case, dissatisfaction could be rooted somewhere else, or could be improved by an information campaign (Eboli and Mazzulla, 2011, p. 180).

This model is sensitive to the choice of objective indicators. If objective indicators and target levels are chosen that flatter the asset manager, the model will also tend towards flattering the asset manager. That said, de Oña and de Oña (2014) identify mixed subjective/objective satisfaction indicators as a promising area for further research.

An additional model, reported by Austroads (2016, p. 46) is the use of an "acceptability function" to "relate the physical condition of an asset to the percentage of road users who regard that condition as satisfactory." Austroads (2016, p. 46) uses the example of road roughness to explain the process,

> *"The function… is based on the assessments of drivers who had just driven over a section of known roughness and were asked whether they thought this level of ride comfort would be acceptable for a 45 minute trip."*

The responses were then plotted against the International Roughness Index (IRI, a widely used measure of road roughness) for the section of road to create the acceptability function. Austroads uses a road roughness acceptability function developed by Potter et al. (1992) in their report. The benefit of acceptability functions is that they relate levels of customer satisfaction with service quality attributes to objective levels of service quality. There are significant costs however. Gathering the relevant information to create an acceptability function is time consuming, expensive, and usually only involves a small group of respondents. Each service quality attribute for each infrastructure asset type requires its own acceptability function, which may be problematic for asset types which customers have infrequent interactions with; and not all asset types have enough variation in service quality for customers to assess and report acceptability. It may be easy to drive to a stretch of road known to have a rougher surface, but how would variation in any service quality aspect be observed in a single airport in one 45 minute period?

These are only some of the models that have been proposed in the literature to model customer satisfaction. A more comprehensive list from de Oña and de Oña (2014) is at Appendix A.

2.6 Determining relative importance of aspects of service quality

For performance measurement to have practical use for infrastructure operators, they need to be able to identify what improvements will have the highest impact on customers' overall satisfaction. This frequently entails determining which aspects of service quality are most important to customers. One widely used method to do this is for operators to ask customers to rate each service quality attribute on an importance scale. There are several problems with this technique, however.

Asking customers to rate importance can lead to "erroneous estimation, because some attributes can be rated as important even though they have little influence on overall quality" (de Oña et al, 2013, p. 219). This is a problem common with *stated preference* methods, which are widely used in agricultural and environmental economics. It is also common in most survey methods. For example, an individual asked if safety is a more important attribute of public transport than, say, punctuality, may be driven to respond 'yes' due to *social desirability* bias, that is, "the tendency on behalf of the subjects to deny socially undesirable traits and to claim socially desirable ones, and the tendency to say things which place the speaker in a favourable light" (Nederhof, 1985, p. 264). This could lead to infrastructure operators investing in safety when, in reality, safety has little impact on customer satisfaction. Social desirability bias is one of many forms of bias that could reduce the validity of stated preference surveys.

Another example is the use of strategic responses by survey respondents. This is particularly relevant when survey respondents have an interest in either improving or worsening survey results to serve their own purposes. The ACCC (2016a, p. 177) notes that airlines have an

incentive to deliberately under-report the quality of the airports they are surveyed about in its *Airport Monitoring Report,* as poor survey results could be used as leverage in commercial negotiations.

An additional problem with stated preference surveys is that customers often tend to rate all factors presented as equally important. For example, de Oña et al (2013, p. 219) found that the average importance rating for the service attributes they surveyed was between 8.60 and 9.14, with little variation among mean values. Austroads (2016, p. 20) experienced a similar phenomenon, with eight of twelve road quality indicators being rated important or very important by over 90 per cent of respondents. Insufficient differentiation among mean importance ratings raises the possibility that tests will lack statistical significance, and thus reduces the possibility that any meaningful lessons can be drawn from data.

For these and other reasons, economists prefer to use *revealed preference* methods based on actual choices made by individuals to determine preferences. However, this may not be possible in monopolistic infrastructure markets. As Loomis (2011, p. 363) explains, "revealed preference methods are of little help when there is no behavioural trail." It is also not entirely clear if revealed preference methods can be extended to things as intangible as infrastructure reliability, safety, or availability. The UK Competition Commission (2010, p. 4), now the Competition and Markets Authority, identifies this as a systemic disadvantage of revealed preference methods, describing the "limited number of cases where non-market values/goods exhibit a quantifiable relationship with market goods." A further problem is that it is difficult to observe consumers changing their behaviour solely in response to changes in individual aspects of service quality. Another common problem in revealed preference method is collinearity among attributes being observed, which Kroes and Sheldon (1988) state make it difficult to predict the effect of a change in any individual attribute.

Recognising these limitations, researchers have tried to diversify away from stated and revealed preference methods, and towards methods that involve deriving importance rankings from customer satisfaction surveys. The two most widely used in the literature are various forms of regression analysis and structural equation modelling (SEM).

The most obvious regression models for customer satisfaction surveys are *ordered logit* and *ordered probit* models, as these allow for non-continuous (ordinal) values in the independent variable, such as the five-point scales commonly used in customer satisfaction surveys.

SEM refers to a series of statistical tools and methods which most frequently involve the identification and measurement of *latent variables* using observed variables, and the simultaneous calculation of the relationships between the latent variables. Latent variables are unobservable factors which observable variables are intended to measure. For example, airline safety is not directly observable or measureable, but it can be inferred through asking customers safety-related questions. SEM uses two models: a measurement model, which "assesses latent variables as linear functions of observed variables," and a structural model, which "shows the direction and strength of the relationships of the latent variables" (Chou and Kim, 2009, p. 6948).

Both logit/probit models and SEM reveal relationships between service quality attributes and overall customer satisfaction that customers do not self-report in customer surveys. Using SEM, Chou and Kim (2009, p. 6951) found that corporate image (measured by asking questions about service punctuality, frequency of trips and whether the company has a "good image and goodwill") has a bigger impact on customers' satisfaction with the high speed rail networks in

Taiwan and South Korea than does technical service quality. More recently, Eboli and Mazzulla (2015, p. 195) applied SEM to a survey of 16 718 customers of a railway service operating in the north of Italy, and found that, contrary to surveys, safety has less impact on customer perceptions of service quality than did the cleanliness of the service, or the provision of information about rail services. Tyrinopolous and Antoniou (2008), using ordered probit models, found that the most important aspects of service quality vary across public transport systems in the same city, reflecting the varied experiences of customers on different networks.

These methods provide a better picture of what aspects of service quality matter most to customers than do raw customer satisfaction surveys. However, there is no evidence as to which method is most accurate; and the literature would benefit from a study that applied multiple methods to the same data to determine if they even produce similar results. Tyrinopolous and Antiniou's (2008) results also raise doubts that customers have universal service quality priorities. It appears that the aspects of service quality that drive customer satisfaction are asset specific and location specific.

2.7 Temporal and spatial considerations

The task of developing an infrastructure performance framework incorporating customer satisfaction is difficult when results need to be compared across jurisdictions. People in different cities may report similar levels of satisfaction with their local services even as their objective performance differs markedly. For example, Londoners report 85 per cent satisfaction with the London Underground, while Sydney-siders report 89 per cent satisfaction with Sydney Trains (TfL, 2017, p. 2; TfNSW, 2016, p. 3). One would have to assume that when asked the question, "How satisfied are you with this service?" Sydney-siders are comparing the Sydney Trains service with their prior experience of Sydney Trains, and not comparing it with the service offered on the London Underground. According to Andersen and Hjortskov (2016, p. 648), this understanding of expectations and satisfaction is commonly assumed in the study of performance evaluation. This is a problem: if all Australians living in cities reported being equally satisfied with the passenger rail service (or any infrastructure) in their city, it would be difficult to use such subjective measures to compare performance across the country.

One solution may be to ask if performance has improved or declined since a previous point in time, but as previously noted, Becker and Albers (2016) found such techniques to be highly unreliable. While Becker and Albers (2016) focused on surveys taking place over a period of months, the issue also applies over longer periods. In 1998, a survey of Telstra customers found that 82 per cent were satisfied with the speed of service restoration on the fixed-line network (PC, 1999, p. 161). At that time, only 54 per cent of metropolitan service faults were being cleared within one working day of notification (PC, 1999, p. 167). By 2016, 91.5 per cent of faults on Telstra's fixed-line network were being restored within one day of notification (the figure was higher for other fixed-line telephone companies), but only 78 per cent of survey respondents were satisfied with the speed of fault repair (ACMA, 2016, p. 116; ACMA, 2016, p. 69). Such a result indicates that people may judge performance based on recent experience, not on the performance they experienced decades ago. Such a phenomena is known as *recency bias*, and presents significant problems if performance is to be measured over long periods (as it would be when measuring the performance of infrastructure), and if direct measures of customer satisfaction were in some way used to incentivise the behaviour of infrastructure operators.

A technique that may help alleviate both of these issues is framing survey questions. James (2011) found that providing more or less information can significantly manipulate survey respondents' reported satisfaction with a service. Survey respondents could be prompted to think about performance now compared to performance in the past, or to compare performance of an infrastructure asset in their own region to that of an asset in a different region (this would rely on respondents having sufficiently detailed knowledge to provide an informed response). However, such techniques are open ended, and can be misused to pose leading questions.

2.8 Concluding remarks

Academics have explored the research issues involved in measuring customer satisfaction and infrastructure service performance for many years. The research highlights that measuring customer satisfaction is far from straightforward. What to measure, how to measure and whom to survey are among the basic questions involved in measuring performance, all of which have potentially numerous answers.

Objective measures of physical infrastructure performance—for example, passenger throughput, physical infrastructure condition, fares, average travel time, etc.—provide reasonably unambiguous indicators of infrastructure performance. Assessing customers' satisfaction with services necessarily entails some type of customer survey—either a stated preference survey or customer satisfaction survey. Measurement frameworks that combine both objective asset performance and subjective customer satisfaction measures, enable 'scaling' of customer-assessed performance against observed outcomes, and a more accurate picture of what factors matter most in term of actually improving customer outcomes.

The following chapter reviews existing performance measurement frameworks applied to measuring and reporting Australian infrastructure performance and compares these with some selected overseas measures.

CHAPTER 3

Infrastructure performance measures in Australia and internationally

Summary

- The practice and availability of infrastructure performance measurement in Australia varies markedly.
- Broadly, performance measures appear more comprehensive and more readily available for publicly-owned and publicly-regulated infrastructure (for example, roads and airports), and far less available for privately-owned and unregulated infrastructure.
- A brief review suggests the situation is broadly similar overseas—with performance measurement frameworks more readily available for publicly-managed infrastructure.

3.1 Introduction

The rigour with which infrastructure performance is measured in Australia varies significantly across asset types. History plays a part. During the privatisation of infrastructure assets throughout the 1990s, the Australian Government generally required that some form of service and price monitoring of newly privatised assets be periodically undertaken. This is the origin of the ACCC's *Airport Monitoring Report*, and the Australian Communication and Media Authority's (ACMA) *Communications Report,* which contains some performance data on Telstra's network. This trend applies to some state-based privatisations as well, most notably Aurizon (a rail freight company and track operator formerly owned by the Queensland Government), which has performance reporting requirements under its third-party access undertaking. Privatised electricity distribution and transmission companies are subject to performance monitoring by virtue of their participation in the NEM, overseen by the Australian Energy Regulator (AER).

Significant gaps remain, however. The performance monitoring of Australia's ports is confined to the operations of stevedores, and so does not include port operators. Transurban, the dominant toll road operator in Australia, does not publish detailed data on the performance of its roads. Gas transmission and distribution companies are not subject to the same degree of benchmarking as their electricity counterparts. Many performance measures, including the AER's electricity distribution and transmission benchmarking, and BITRE's *Waterline*, only focus of select measures of performance, such as productivity, and do not look at performance from the customer's perspective.

While shortcomings in performance measurement should be addressed, performance measurement should not be viewed in isolation. Performance measurement is not an ends in itself. Infrastructure operators should be incentivised to act on performance data, especially if they operate in markets with little competition. In addition, performance measurement is not necessarily a substitute for competition, market design and/or economic regulation.

This chapter presents an overview of infrastructure performance frameworks in Australia and overseas created by both public and private sector organisations. There is a particular focus on roads, as there has been significant work done in recent years to measure road performance. Appendix B includes more detailed tables of relevant frameworks.

3.2 Road-related performance measures in Australia

All Australian states and territories have, or acknowledge the need for, a road performance framework. They vary in terms of purpose, scope, complexity, and degree of implementation. Most do not include any direct measures of customer satisfaction, and those that do tend only to use a single question on overall customer satisfaction with the road network. The lack of harmonisation between state and territory road performance frameworks is emblematic of the infrastructure sector as a whole.

Australia: Austroads National Performance Indicators

Austroads is the peak organisation of Australian and New Zealand road transport and traffic agencies. The organisation undertakes road and transport research, and publishes guidance on the design, construction and management of road networks and their associated infrastructure. Austroads has been working for many years to develop methods for gauging customer satisfaction with road agencies and the networks they operate.

The Austroads (2017) National Performance Indicators (NPI) are a series of 58 metrics for which Australian and New Zealand road agencies provide uniform data. The current set of metrics comprise principally objective measures and one user perception measure—a road user satisfaction index.[2] (Austroads' NPI are listed in Appendix Table B.1.)

Australia: Austroads Levels of Service Framework for Non-Freight Users

Austroads' Levels of Service (LOS) Framework for Non-Freight Users builds upon previous work done to quantify community expectations on the levels of service for road networks, and to develop levels of service metrics for network operations planning (Austroads, 2016). The framework differs from those currently used by road agencies in that it assesses the importance of different aspects of the road system to road users through customer surveys, rather than using assumptions made by road agency staff.

2 Austroads User Satisfaction Index (USI) is derived from a telephone survey of road users aged 17 years or over across Australia and in New Zealand. Respondents are asked to rate their satisfaction with the provision of different road attributes and with the overall road aspect. Road attributes surveyed include: road network condition, safety, environmental issues, community needs and consultation, and travel time and congestion. Further details available at Austroads NPI (http://algin.net/austroads/site/).

The Austroads framework also uses the concept of an acceptability function, which "relates the physical condition of an asset to the percentage of road users who regard that condition as satisfactory" (Austroads, 2016, p. 46). The framework does not currently detail what acceptable levels of service are for each of the indicators, as these would need to be developed separately using either community consultation or professional judgement (for example, to determine if road pavement and bridges have sufficient strength for expected traffic). The combination of road user surveys and acceptability functions makes it possible to weight various quantitative performance metrics according to their importance to road users, and to inform agencies as to what levels of performance are acceptable to road users. This methodology is more rigorous than that used in existing LOS frameworks, which either rely solely on quantitative metrics chosen by road agencies, and/or asking road users about their overall satisfaction with the road network.

As the result of a research project, the Levels of Service Framework for Non-Freight Users is intended to guide member agencies in the development of a best practice framework, rather than replace existing performance measurement frameworks. To date, it has not been implemented. (The performance measures in Austroads' Levels of Service Framework for Non-Freight Users are listed in Appendix Table B.2.)

Australia: Austroads Heavy Vehicle Infrastructure Rating

As part of the Transport and Infrastructure Council's (TIC)[3] heavy vehicle road reform (HVRR) program an Austroads (2015) report was commissioned to develop a heavy vehicle infrastructure rating (HVIR) for each 100 metre section of Australia's national key freight routes.

The HVIR consists of three components:

- Access – based on the mass limit and length limit of the road section (40 per cent weighting in HVIR).
- Ride quality – based on the International Roughness Index (IRI) score of the road section, a quantitative measure of road surface smoothness (40 per cent weighting in HVIR).
- Safety – based on the lane width and sealed shoulder width of the road section (20 per cent weighting in HVIR).

The HVIR includes expected minimum and maximum scores for each road category (which range from freeway/motorways to access roads). Road sections scoring above the HVIR expected maximum score are rated high, those between the maximum and the minimum are rated medium, and road sections below the minimum score are rated low. Each component has a formula and associated values to calculate the expected minimum and maximum scores for each component. (The HVIR frameworks for each of the three components can be found in Appendix Tables B.3, B.4 and B.5.)

Most states and territories have already released map files and spreadsheet/data files containing their national key freight routes and associated HVIRs.

3 The Transport and Infrastructure Council (the Council) comprises Commonwealth, State, Territory and New Zealand Ministers with responsibility for transport and infrastructure issues, as well as the Australian Local Government Association.

TIC (2016a, p. 1) notes that the HVIR "has necessarily been kept relatively simple for this first edition, which is primarily a proof of concept." It also notes that the states and territories used differing methodologies to record road infrastructure rating measurements, urging caution when comparing data between jurisdictions.

The HVIR represents an interesting case of the role of infrastructure performance measurement as a form of accountability and transparency. Under a "full" heavy vehicle road reform scenario, user charges would reflect each vehicle's share of the road cost, based on their road usage (TIC, 2016b, p. 4). It is hard to imagine such a fundamental shift in road funding occurring unless road users could be assured that their payments are linked to a certain level of service quality.

Western Australia: Main Roads Western Australia Key Performance Measures

Main Roads Western Australia (MRWA) is the Western Australian Government agency responsible for planning, building and maintaining the 18 500 kilometre network of state roads (MRWA, 2016a). In 2012, MRWA introduced a suite of key performance indicators based on data collected by the agency, and on an annual Community Perceptions Survey, which asks Western Australians about their level of satisfaction with MRWA, road safety, maintenance, and the provision of cycleway and pedestrian facilities. The indicators are divided into effectiveness indicators, and efficiency indicators. Only the effectiveness indicators are of interest here, as the efficiency indicators solely measure if projects and contracts were completed on time and on budget, and the average cost of the road network. In its handbook explaining the methodology of the indicators, MRWA notes which indicators could be manipulated by staff and what steps have been taken to prevent this from happening. (MRWA's Key Performance Measures are listed in Appendix Table B.6.)

Victoria: VicRoads Benefit Management Framework, Version 2

The Roads Corporation of Victoria (VicRoads) is the statutory agency in Victoria responsible for the planning, maintenance and construction of the state road network. VicRoads' Benefit Management Framework "enables a consistent approach to identifying, monitoring and evaluating the success of VicRoads' investments. It provides a 'line of sight' from investment-level indicators to the benefits and outcomes that VicRoads and ultimately the government aims to achieve" (VicRoads, 2017). (VicRoads' Benefit Management Framework performance measures are listed in Appendix Table B.7.)

The framework identifies five outcomes that VicRoads seeks from its investments: better value for money, productivity and economic growth, community health and wellbeing, road safety, and environmental sustainability (VicRoads, 2015). From these, a significant number of measures are drawn, along with where the data can be sourced. The application of the Framework is project specific; that is, if a project does not aim to achieve improvements in productivity and economic growth, this outcome will not require measurement. The choice of measures also appears to be at the discretion of VicRoads. While the framework aligns with VicRoads' Strategic Commitment in its 2015–2019 corporate plan, it does not specifically align with the performance targets that the agency has set itself in the plan.

Tasmania: State Roads Level of Service Framework

The Department of State Growth (DSG) is the Tasmanian Government agency responsible for transport infrastructure planning and delivery, and transport management. DSG's State Roads Levels of Service Framework identifies four customer service outcomes: function, safety, capacity, and condition. For each of these there are supporting customer performance measures, and expected service levels for each road category in Tasmania. (Tasmania's State Roads Levels of Service Framework measures are listed in Appendix Table B.8.) However, many of the technical performance indicators are written as expected outcomes rather than quantitative measures or targets. For example, the technical performance measures for roadside condition are "Measurement of community response to roadside condition," and "Roadside aesthetics should reflect the surrounding land use and the transport corridor within that environment" (DSG, 2016a).

The DSG (2015) each year issues a *State of our Roads* report, which measures traffic volumes (both light and heavy vehicles); road pavement, seal and bridge age; and roughness, rutting and surface cracking on sealed roads, on all roads managed by the Tasmanian Government. The Department of State Growth's (2016b) annual report states that this information "will be complemented by reporting on Key Performance Indicators related to specific levels of service expected by our customers."

Queensland: Department of Transport and Main Roads Service Delivery Statement

The Queensland Government's Department of Transport and Main Roads (TMR) is responsible for the planning, management and delivery of the State's transport network, including road, rail, aviation and maritime.

While TMR does not have a road asset performance framework, the Queensland Government budget papers do include quantitative metrics (TMR, 2016)—reproduced in Appendix Table B.9. A project to develop a performance framework was abandoned when larger reforms to the TMR's asset management system were deemed too expensive (Cowan, 2015).

New South Wales: Roads and Maritime Services Business Results

RMS is the statutory agency of the New South Wales Government with responsibility for the construction and maintenance of the State's road network, along with roads in unincorporated areas of NSW.

RMS does not have a framework to determine the performance of its road network, but instead publishes several key performance indicators related to customer satisfaction, including targets, in its annual report (RMS, 2016)— reproduced in Appendix Table B.10.

Previous annual reports have included statistics on the percentage of pavement on RMS roads rebuilt, the percentage of RMS roads resealed, and the percentage of asphalt surfaces renewed in the previous year, but these are not included in the 2015–16 annual report (RMS, 2016).

Northern Territory: Roads and Bridges Strategy

The Northern Territory Department of Infrastructure, Planning and Logistics (recently formed by a merger of several departments, including the Department of Transport) is the Northern Territory Government agency responsible for planning, construction and maintenance of the 22 000km of roads controlled by the territory government, 70 per cent of which are unsealed.

The former-Department of Transport's (2016a) Roads and Bridges Strategy alludes to the existence of a levels of service framework, which "defines the type and quality of road-related assets that should be provided and maintained," but it does not appear to be publicly available. The Roads and Bridges Strategy states that, "Communicating [sic] with stakeholders and the community about levels of service and performance criteria is undertaken to provide input to the maintenance of the road network and associated works programs," but there is no publicly-available information on how this process operates in practice.

The Roads and Bridges Strategy includes strategic objectives for the development of the road network, but does not identify quantitative metrics to measure its progress towards achieving them. The former-Department of Transport's (2016b) annual report contains key performance indicators; however, none measures the performance of the road network beyond a user satisfaction score taken from Austroads National Performance Indicators.

South Australia

The South Australia Department of Planning, Transport and Infrastructure does not appear to have a performance measurement framework. The Department's (2016) 2016–2020 strategic plan identifies desired outcomes for transport in general, while noting that key performance indicators are still being developed to measure progress towards them.

Australian Capital Territory: Roads ACT Strategic Asset Management Plan

Roads ACT is a unit within the ACT Government's Transport Canberra and City Services Directorate (TCCS) with responsibility for the management, use and maintenance of the Territory's roads and related assets. Roads ACT's (2013) Levels of Service Framework is contained with the agency's Strategic Asset Management Plan. Roads ACT (2013) has identified nine key service attributes that are "recognisable from a customer point of view": Accessibility, affordability, health and safety, quantity, quality, reliability, responsiveness, sustainability, and timeliness. These attributes inform the selection of performance metrics in the framework. The framework links levels of service to TCCS and ACT Government strategic policies. Roads ACT is currently in the process of producing a new Strategic Asset Management Plan to replace the 2013–2016 version, and as such the current levels of service framework may be subject to change.

The framework itself identifies technical measures, locations of performance data (such as specific ACT Government reports), current performance, and targets. Similar to other frameworks used in Australia, the Roads ACT LOS framework uses the Austroads user satisfaction score as a direct measure of customer satisfaction. One shortcoming of the framework is that the identified "Customer Measures" comprise an inconsistent mix of specific performance measures, specific goals, and broader objectives. For example, "Number of deaths

per 100,000 population" is a specific performance measure, whereas "Variation on trip to work is no more than 5 minutes" is an overarching goal encompassing broadly related network travel speed indicators, but no direct measure of variation. A final example of a customer measure is "Attractive road infrastructure," which is a broader objective. (Roads ACT's Strategic Asset Management Plan performance measures are listed in Appendix Table B.11.)

3.3 Road-related performance measures overseas

New Zealand: One Network Road Classification Performance Measures

The New Zealand Transport Agency (NZTA), the government agency responsible for funding, planning and managing the country's land transport system, developed the One Network Road Classification (ONRC) as a means to "standardise the performance of roads throughout New Zealand" (NZTA, 2016a, p. 4). The ONRC contains nine customer outcome performance measures and 13 technical output performance measures under five customer levels of service categories: mobility, safety, amenity, accessibility, and travel time reliability. The NZTA provides detailed guidance to local authorities on how to measure and assess these outputs and outcomes, and an online portal to submit data. While "the most important concept behind the ONRC is that it places the customer at the heart of every investment decision," it does not include any direct measures of customer satisfaction (NZTA, 2016b, p. 3). Notably, the ONRC does not yet specify target levels for outcomes or outputs. (NZTA's ONRC performance measures are listed in Appendix Table B.12.)

England: Highways England Performance Specification

Highways England is a statutory corporation owned by the UK Government responsible for managing and building motorways and major roads—together known as the Strategic Road Network (SRN)—in England. The company is governed by a Road Investment Strategy (RIS) issued by the Department for Transport (2015), which in turn is responsible for oversight of Highways England through the Highways Monitor. The RIS includes a Performance Statement, which provides targets on key performance indicators that the Department for Transport expects Highways England to achieve.

The RIS also directed Highways England to create a broader suite of performance indicators, which it has since done. Highways England has eight key performance indicators (KPIs), supported by a further 11 performance indicators (PIs), listed in Appendix Table B.13. The details of these indicators, including methodology, risks, assumptions, reporting and approvals requirements, and interdependencies with other indicators, are provided in the *Operational Metrics Manual* (Highways England, 2016a).

Improvement in customer satisfaction with Highways England's network is an explicit target set by the Department for Transport. Highways England (2016b) commissions an annual National Road User Satisfaction Survey (NRUSS), which asks road users to rate and provide feedback on various aspects of the road network, including roadworks management, safety, journey time, general upkeep, and signage. Transport Focus (2015), a British Government watchdog for passengers and road users that works with Highways England, has previously conducted

research into the needs and experience of road users, as well as surveyed road users on their priorities for improvement to the SRN. The Highways Monitor reported in 2016 that Highways England is trialling and evaluating a number of initiatives to improve customer experience, and that it would be undertaking an in-depth review of Highways England's plans to improve customer satisfaction in 2017 (ORR, 2016).

The Highways England customer satisfaction measures appear more detailed than measures of road user customer satisfaction collected by Australian road agencies. It is not clear that such a focus on customer service could be readily transplanted to Australian road agencies, as the English model works as a mesh of interlocking commitments and institutions. In particular:

- Highways England is a publicly-owned company with substantial independence from Government and five-year funding certainty. Moreover, Highways England has a ring-fenced (protected from budget cuts) "Innovation Fund" to trial new technologies. Highways England sole function is to plan, build and manage its road network (other activities, such as driver licensing, are done by other agencies).
- Highways England employs private-sector performance management tools, such as performance pay for staff.
- Customer satisfaction is an explicit goal of Highways England.
- Transport Focus is tasked with lobbying Highways England to improve road users' experience.
- The Highways Monitor ensures that Highways England is doing enough to work towards its targets.

United States: Federal Highway Administration National Performance Management Measures

The Federal Highway Administration (FHWA) is a US Government agency which overseas funding for the construction and maintenance of the National Highway System (NHS), including the Interstate Highways network. The FHWA's National Performance Management Measures (NPMM) were mandated as part of the *Moving Ahead for Progress in the 21st Century Act* (MAP-21), passed in 2012, and the *Fixing America's Surface Transportation Act* (FAST Act), passed in 2015. The two Acts marked the first time the US Government sought to measure the performance of the NHS on which it spends roughly US$46 billion annually (CBO, 2015).

MAP-21 established national goals for the Federal-aid highway program, around which the FHWA has structured the NPMM, requiring:

- State Departments of Transportation (State DOTs) and large cities in receipt of Federal funds to implement performance targets for the parts of the NHS they administer;
- State DOTs and large cities to develop plans that provide strategic direction for addressing performance needs;
- State DOTs and large cities to submit biennial reports to FHWA on the condition and performance of the NHS within their jurisdictions; and
- State DOTs to make significant progress toward meeting their targets.

(A list of the FHWA NPMM is reproduced in Appendix Table B.14.)

Unlike the Highways England framework and frameworks employed by some State DOTs, the NPMM does not include any direct measures of customer satisfaction.

Goals for investments in the NHS (noting that targets have not yet been set) include:

- Safety – to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State owned public roads and roads on tribal lands.
- Infrastructure condition – to maintain the highway infrastructure asset system in a state of good repair.
- Congestion reduction – to achieve a significant reduction in congestion on the NHS.
- System reliability – to improve the efficiency of the surface transportation system.
- Freight movement and economic vitality – to improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
- Environmental sustainability – to enhance the performance of the transportation system while protecting and enhancing the natural environment.
- Reduced project delivery delays – to reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

Even though the final FHWA rules only came into effect in February 2017, many State DOTs commenced collection and publication of relevant data on their websites well ahead of time.

Florida: Department of Transportation Performance Framework

The Florida Department of Transportation (FDOT) is a decentralized cabinet agency of the Florida Government. FDOT's (2017) head office is responsible for departmental policies, rules, procedures, and standards and ensures uniform compliance and quality performance by the seven district offices that implement transportation programs.

FDOT's (2015) performance framework has been identified as one of three implementations demonstrating best practice in LOS frameworks in the United States (Transportation Research Board, 2010). The performance framework includes a combination of quantitative metrics, composite scores, as well as results from a biannual customer satisfaction survey, which asks both Florida residents and visitors to the state (whom travelled by car) for their perceptions of the state highway system. (The FDOT's performance framework measures are listed in Appendix Table B.15.)

There is, however, a contradiction implicit in the FDOT framework. The agency describes its LOS framework as a "quantitative stratification" of users' satisfaction with the state road network, but then also includes customer survey results in the framework. They are implicitly measuring the same thing, and yet the results for both measures are markedly different: FDOT (2015) reports that 83 per cent of roads are meeting its LOS standard, but that only 74 per cent of Floridians are satisfied with them. More paradoxically, between 2009 and 2014, LOS scores stayed flat while customer satisfaction rose from 68 per cent to 74 per cent. Over the period, no objective measure of travel time reliability, congestion, or average speed changed by more than a percentage point.

3.4 Non-road related infrastructure performance measures in Australia

Australia Competition and Consumer Commission Airport Monitoring Report

The ACCC is a statutory agency of the Australian Government, responsible for competition law, pricing regulation and surveillance, and economic regulation of certain industries and utilities. Under the *Competition and Consumer Act 2010*, and the *Airports Act 1996*, the ACCC monitors quality, prices, costs and profits relating to the supply of aeronautical services and facilities and of car parking services supplied at Brisbane, Melbourne (Tullamarine), Perth and Sydney (Kingsford Smith) airports.

As part of this monitoring, the ACCC (2016a) undertakes annual surveys of passengers, airlines, and landside operators (taxi companies, transport companies, off-airport carpark owners, etc.), for inclusion alongside objective measures. The survey responses and objective measures are then combined into an overall quality of service rating from both the passengers' and the airlines' perspective. (Tables B.16 and B.17 list the framework and measures underpinning the ACCC's passenger-related services and facilities and aircraft-related services and facilities components.) The ACCC does not publish the methodology behind how it combines the objective and subjective measures of service quality. Passenger perception surveys, airline surveys and landside operator surveys are conducted by asking respondents to rate various aspects of monitored airports on a scale of one to five. The ACCC then converts the results into a scale ranging from "very poor" to "excellent".

The ACCC (2016a, p. 12) notes of the passenger perception survey,

> *"while passengers' perceptions are critical, they may be affected by service providers other than the actual airport itself. These can include the airlines they use, ground-handling services provided by third parties, airport security and border force personnel for example. While these third parties may bias some passenger responses, the ACCC considers that passengers' perceptions provide an important outlook on quality of service at airports."*

It also notes of airlines,

> *"the ACCC is aware that airlines, as customers of airports and primary users of their facilities, may be commercially motivated to rate down quality of service at individual airports. Typically, airline ratings have been much more volatile (and generally lower) than passenger ratings"* (ACCC, 2016a, p. 16).

The ACCC's monitoring scheme is similar in scope to the UK Civil Aviation Authority's (CAA) Service Quality Rebate and Bonus Scheme in place for Heathrow Airport in London. That scheme also involves a combination of customer survey and objective measures of airport performance. The notable difference is that if customer satisfaction and performance at Heathrow Airport drop below a set threshold, the airport must pay a rebate to airlines up to a maximum of 7 per cent of airport charges (Heathrow Airport 2017). The scheme also includes a bonus payment element if the airport achieves high customer satisfaction ratings across four of its terminals.

Australian Energy Regulator Annual Benchmarking Reports

The AER regulates energy markets and networks in Queensland, New South Wales, Victoria, Tasmania, and South Australia. Together, these states form the NEM. The AER oversees wholesale electricity and gas markets, sets the amount of revenue that distribution and transmission companies can recover from customers, and regulates retail energy markets in all NEM states except Victoria.

Each year the AER (2016a; 2016b) publishes benchmarking reports on the performance of electricity transmission and distribution companies in the NEM. The reports are narrow in scope, focusing only on the efficiency of distribution and transmission companies as measured by multilateral total factor productivity (MTFP), and multilateral partial factor productivity (MPFP), which measures the productivity of either operational expenditure or capital stock. The multilateral method enables comparison of both productivity levels and productivity trends (AER, 2016a, p. 10).

The AER uses these measures to rank each of the 13 distribution companies in the NEM by MTFP. Partial performance indicators are also included in the reports, which present inputs costs relative to a particular output. For example, total costs per customer, total cost per megawatt (MW) of maximum demand, and total cost per kilometre of circuit line length. The AER also ranks transmission companies using the same MTFP methodology, but uses different partial performance indicators to reflect the different function of transmission companies compared to distributors. The benchmarking reports do not include customer satisfaction measures.

Australian Rail Track Corporation Performance Indicator Reporting

The Australian Rail Track Corporation (ARTC) is an Australian Government-owned corporation responsible for the operation and maintenance of interstate railway track in Western Australia, South Australia, Victoria, New South Wales, and Queensland, as well as the Hunter Valley coal rail network.

The ARTC's (2008) performance indicators are included in its third-party access undertaking, approved by the ACCC. The indicators are grouped under the headings of reliability, network availability, transit time, temporary speed restrictions, and track condition. (Appendix Table B.18 lists ARTC's performance indicators.) Performance indicators relating to unit costs have not been updated since 2014. Most indicators are reported separately for the various geographical segments of ARTC's network, specifically East-West,[4] Melbourne-Sydney, Sydney-Brisbane, and Melbourne-Brisbane. However, the access undertaking states that reporting of network availability only applies to the Melbourne-Parkeston, Melbourne-Macarthur, Newcastle-Queensland Border, and Cootamundra-Crystal Brook sections of the network. The ARTC access undertaking includes which party is responsible for collecting the data for each indicator.

4 Comprising ARTC rail segments Cootamundra–Kalgoorlie and between Melbourne–Crystal Brook.

Australian Communications and Media Authority Communications Report

ACMA is Australia's media and communications regulator, overseeing content and infrastructure regulation, licensing, and industry codes of practice. As part of the privatisation of Telstra (the former public telecommunications monopoly), ACMA was tasked with monitoring the performance of service providers and networks, with particular reference to consumer satisfaction, consumer benefits and quality of service (*Telecommunications Act 1997* s 105(1)).

ACMA's (2016) annual *Communications Report* includes the performance measures that ACMA evaluates. Conclusions are drawn individually, rather than being informed by an overarching framework. Despite this, ACMA groups some of its measures under headings used by other performance frameworks, including availability and reliability (however, most availability measures consist of the number of currently active mobile/fixed-line/internet services). One of the reasons for the lack of overarching framework may be that performance data is mandated by different secondary legislation. For example, data on standard fixed-line telephone services is collected under the Telecommunications (Customer Service Guarantee) Standard 2011 and the Telecommunications (Customer Service Guarantee—Retail Performance Benchmarks) Instrument (No. 1) 2011, while reliability of Telstra's fixed-line telephone service is governed by the Carrier Licence Conditions (Telstra Corporation Limited) Declaration 1997.

ACMA commissions customer satisfaction surveys to measure Australian's perceptions of various aspects of mobile and fixed-line telephony and internet service quality, including service reliability, price, billing information, mobile and fixed-line data speeds, and call quality. (The telecommunications performance measures and customer survey reported in ACMA's *Communications Report* are listed in Appendix Tables B.19, B.20 and B.21.)

Water Services Association of Australia Liveability Indicators

The Water Services Association of Australia (WSAA) is the peak industry body representing Australia's urban water industry. The membership of the WSAA consists primarily of government-owned water corporations and state government agencies.

The WSAA (2016, p. 14) released a number of "liveability indicators" to "assist utilities in measuring the contribution they make in liveability," which can be found in Appendix Table B.22. The project grew out of previous papers released by the WSAA into urban water planning, and the role of the urban water utilities in contributing to liveability. The WSAA sourced indicators from a variety of stakeholders, including WSAA members, local councils, and the Collaborative Research Centre for Water Sensitive Cities. The WSAA (2016, p.14) identifies three overarching contributions that the water industry makes to liveability, including value statements, under which indicators are grouped:

- Amenity and community wellbeing – We work to maintain the health of our cities, and to understand our customers' values and aspirations for the liveability of our cities.
- Productivity – We harness the full productivity of our people and infrastructure to ensure that water services remain affordable.
- Sustainability and future focus – By applying science and understanding risk we contribute to long-term sustainability of our cities.

The indicators are further grouped into the following four types:

- Context – Indirect indicators that may be useful for understanding the environment related to a specific issue.
- Input – These look at the actions taken to achieve outcomes (such as policies, practices, programs, processes, investment etc.)
- Output – Something delivered by a program or activity ideally aligned to the achieving of one or more outcomes.
- Outcome – These measure the extent to which the organisation has met its liveability objectives. (WSAA, 2016, p. 14)

For each indicator, WSAA identifies the purpose of each indicator, and measurable metrics for the indicator. The WSAA identifies which metrics are currently used, and which are proposed metrics, as well as which indicators (notably the Context indicators) water utilities have little power to influence.

The WSAA (2016, p. 15) presents the liveability indicators as a "suite" from which they encourage utilities to select between 9 and 12 to focus on, taking into account their corporate objectives and the "things that matter most to the community and customers." The WSAA also encourages water utilities to set their own target for the indicators they select.

Fremantle Ports Performance Management Framework

Fremantle Ports (the trading name of the Fremantle Port Authority) is the state government-owned operator of the Port of Fremantle, the largest port in Western Australia. Fremantle Ports is required to report annually on its performance indicators as part of long-standing requirement for all Western Australian public sector entities.

The performance indicators (listed in Appendix Table B.23) used by Fremantle Ports (2016) are linked to four priorities set by the Western Australian Government:

- results-based service delivery;
- financial and economic responsibility;
- social and environmental responsibility; and
- state building – major projects.

These are then linked to Fremantle Ports' objectives, and to key outcomes sought from meeting the objectives. For each priority, Fremantle Ports lists measures to achieve the outcomes, and results.

One of the main shortcomings is that some of the measures Fremantle Ports identifies are not within the port's ability to influence, or are only partially influenced by the port. For example, container park utilisation rates are a product of the amount of trade taking place at the port, which Fremantle Ports has limited scope to influence. It thus might not be a useful measure of the performance of the port. A similar criticism can be levelled at the use of "trade outcomes compared to budget and forecasts" as a measure of "financial and economic responsibility".

Reporting on the measures Fremantle Ports lists is also inconsistent. Some measures have directly corresponding results. However, many reported results do not link to any measure, and some measures have vague, or even no, reported results. For example, the measure, "truck turnaround times" has the result, "2015 survey shows improvement in trucking productivity and reduced empty running of trucks," rather than relevant quantitative results (Fremantle Ports, 2016, p. 17). Similarly, there are no reported results for the number of complaints received by the port, and the result, "Recognition for excellence in waste-management handling" is not linked to any measure (Fremantle Ports, 2016, p. 19).

Aurizon Network Performance Report

Aurizon is Australia's largest freight rail operator. The company owns and operates an above rail business that transports coal, iron ore and freight. In addition, it operates the 2 670 kilometre Central Queensland Coal Network (CQCN), a rail network servicing Queensland's coal mines, under a 99-year lease from the Queensland Government. Access to the CQCN is governed by a third-party access undertaking, approved by the Queensland Competition Authority (QCA), and certified as an "effective access regime" by the ACCC.

The access undertaking includes a requirement that Aurizon report monthly on the performance of the CQCN, using indicators set out in the access undertaking (Aurizon, 2016a). These cover attributes including on-time performance, safety incidents, track condition and track utilisation (Aurizon, 2017). The annual performance report also includes measures relating to complaints and application approvals, but apart from these, the report provides no other customer satisfaction measures (Aurizon, 2016b). (The performance measures reported in Aurizon's quarterly network performance report are listed in Appendix Table B.24.)

3.5 Non-road related performance measures overseas

There are a wide range of non-road related infrastructure performance measurement frameworks in use around the world. Examples of infrastructure sectors measuring performance include European railways (European Railway Performance Index), and international shipping (BIMCO Shipping KPIs). Other high-profile performance frameworks include the Airports Council International's (ACI) Airport Service Quality survey, and the International Air Transport Association's (IATA) Global Passenger Survey (which measures airline performance), however detailed information and results for both of these is restricted to paying members of each respective organisation. This section reviews just a few of the readily available performance measures.

European Union: Consumer Market Monitoring Survey

The Consumers, Health, Agriculture and Food Executive Agency (CHAFEA) is a research and funding body of the European Union (EU), responsible for implementing and monitoring programs established by the European Parliament and European Council.

Since 2010 CHAFEA (2016) has commissioned five waves of the Consumer Market Monitoring Survey (MMS), which evaluates customer satisfaction across 42 product and

service categories in the 28 EU Member States (as well as Norway and Iceland), including the following infrastructure markets:

- fixed telephone services;
- mobile telephone services;
- internet provision;
- tram, local bus, metro;
- train services;
- airline services;
- water supply;
- electricity services; and
- gas services.

The MMS asks respondents their views on a variety of aspects of their experience with a particular good or service. Respondents are screened before being asked about a particular good or service, with people who had not purchased the good or service in the previous 12 months excluded from the survey. (The product or service performance aspects covered by the MMS are listed in Appendix Table C.25.)

Respondents are additionally asked to rate the importance of five components of product and service markets: comparability, trust, problems and detriments, expectations and choice. These are used to weight responses to previous questions into a Market Performance Indicator (MPI). The weights do not vary much from an even distribution, with each component varying between 18 per cent and 21 per cent across all product categories. The MMS does not include any objective performance measures in the monitored markets.

World Bank Logistics Performance Index

The World Bank's (2016) Logistics Performance Index (LPI) is a "structured online survey of logistics professionals at multinational freight forwarders and at the main express carriers." It asks respondents a series of questions on a five-point Likert scale about the ease of importing and exporting goods to and from the eight most important trading partner countries to the respondent's home country, with some adjustments to ensure smaller and less-developed countries receive a statistically valid number of ratings. Respondents are also asked to answer a more detailed set of questions about their home country for use in a Domestic LPI. (The performance criteria covered in the LPI and Domestic LPI are listed in Appendix Tables C.26 and C.27.)

The LPI suffers from weaknesses in the scale of its data collection. In 2016, there were only 1051 respondents across 132 countries. While this should mean each country receives an average of 63 responses on the LPI (each respondent answers questions about eight countries), Domestic LPI scores (respondents rating their home county) show that some countries had very few survey participants. In the 2016 survey, for example, there appears to have been only one respondent from Australia, with every question receiving either a score of 100 per cent, or 0 per cent. Such small sample sizes and a clustering of scores in the middle of the distribution also means that confidence intervals are quite large. The World Bank states that on average the intervals translate into ±20 rank places.

In addition, it does not appear that respondents are required to have had any experience with the countries they are asked to rate. For example, the sample 2014 questionnaire had a respondent from the United States rating South Korea, Taiwan, Chad, Georgia, El Salvador, Denmark, Sudan and Libya (World Bank, 2014). Considering that three-quarters of survey respondents worked in companies with less than 250 employees, and that 53 per cent of respondents were senior executives in their companies, it is perhaps unwise to assume that all respondents have sufficiently detailed knowledge of the countries they are rating to develop informed conclusions. Indeed, the LPI is more of a logistics perceptions index than a logistics performance index.

Nonetheless, as with asking drivers to rate their satisfaction with the roads they drive on, so too can the Domestic LPI be seen to some degree as a gauge of industry's satisfaction with infrastructure in their home countries.

BIMCO Shipping KPI Standard and System

The Baltic and International Maritime Council (BIMCO) is the largest international shipping association, representing shipowners, operators, managers, brokers and agents. In 2015, BIMCO took over responsibility for the Shipping KPI Standard and System from InterManager, a ship managers association. The Shipping KPI framework was developed in collaboration with more than 20 shipping-related companies and interested organisations.

The BIMCO (2017a) Shipping KPI framework allows shipowners to input various ship attributes, including ship length, country of origin, nationality of officers, ship type and year built, and benchmark their performance against that of similar ships.

The Shipping KPI framework itself is a hierarchy of three levels of indicators:

- Performance indicators (PI) – 66 directly observable measures for each ship using the system. PIs are reported by each ship through the Shipping KPI website. Some examples of PIs are number of collisions, and number of on-board fire incidents.
- Key Performance Indicators (KPI) – 34 expressions of performance within a particular area. These are created from mathematical combinations of PIs and normalised to a scale from zero to 100, where a higher rating indicates higher performance. The calculation varies for each KPI, but mostly involves calculating ratios or weighted/unweighted averages. Each KPI description explains which calculated value will result in a score of zero and which will result in a score of 100 once the KPI is normalised. Some examples of KPIs include budget performance and ship availability.
- Shipping Performance Indexes (SPI) – aggregated expressions of performance within a particular area. The eight SPIs are unweighted averages of relevant KPIs on a scale from zero to 100. Some KPIs are included in multiple SPIs, for example, the "crew planning" KPI is used in the calculation of all SPIs. (An example of how the SPI is broken down into KPIs and PIs is presented in Appendix Table B.28.)

Data from the Shipping KPI system is only available to BIMCO members, so the extent to which the framework is of benefit to customers of shipowners is unclear. Many of the PIs and KPIs are of interest only to ship owners, including the duration a ship is dry-docked (usually for maintenance or repair). Some may be of interest to customers, for example, the number of navigational incidents and number of security-related deficiencies are PIs which may indicate

to customers the reliability of the ship. If the Shipping KPI system drives competition between shipowners, it is possible that it may improve the level of service customers receive. Currently, however, without public reporting the Shipping KPI framework is used solely for the benefit of BIMCO members.

BCG European Railway Performance Index

The Boston Consulting Group (BCG) is a global management consulting firm. The European Railway Performance Index (RPI) was created in 2012 to benchmark the performance of 25 European national railway systems. BCG (2017) identifies three dimensions of railway system performance: intensity of use, quality of service, and safety. Each dimension consists of several equally-weighted indicators, and the overall RPI is an equal weighting of the three dimensions. (The EPI indicators are listed in Appendix Table B.29.)

BCG (2017, p. 4) helpfully acknowledge three methodological biases in their index, namely that:

- the index overweights passenger performance relative to freight due to a lack of reliable freight data;
- Geographically larger countries are favoured relative to small countries as high-speed rail is more common in countries with longer networks; and
- Countries with lower purchasing power are favoured over those with higher purchasing power, as fares are not weighted on the basis of purchasing power parity.

The RPI does not include a direct measure of customer satisfaction, and it is unclear how indicators were chosen or the reason for each indicator's weighting. A further limitation is the age of the data used by the RPI. Data is sourced from the International Union of Railways (UIC) database. The 2017 RPI uses data from 2014, limiting the index's uses beyond historical cross-country benchmarking.

3.6 Concluding remarks

This chapter has provided an overview of infrastructure performance measurement frameworks currently used in monitoring performance of Australian infrastructure sectors, comparing and contrasting with similar measures overseas.

Most public-sector or publicly-reported performance measurement frameworks predominantly comprise objective performance data with some customer/user survey-based measures. Many Australian road authorities use performance measurement frameworks of this type. In many of these frameworks, the link between customer satisfaction outcomes and infrastructure manager activity is unclear. Highways England's framework places far more emphasis of delivering improved road user experiences, with explicit targets set that Highways England must achieve.

Private sector performance measures, somewhat in contrast, appear to be employed more as benchmarking exercises for use solely by industry participants. BIMCO Shipping KPI scores, for example, are only available to BIMCO members, as are results (and even methodology) for IATA's Global Passenger Survey, and ACI's Airport Service Quality survey. The other striking factor is that performance measurement frameworks made by the private sector rely on significant government involvement. The WSAA's Liveability Indicators would need to be implemented by state-owned water companies. The RPI relies on data from European rail networks, none of which are completely privatised. Britain and Sweden are the only EU member states with fully-liberalised passenger rail markets, yet in both of these countries, the rail track is owned and operated by the state (European Commission, 2013, p. 16; Swedish Transport Administration 2017; NetworkRail 2017).

CHAPTER 4

Private sector infrastructure investment and performance measurement

Summary

- Much of Australia's major infrastructure assets are today owned and operated by the private sector.
- Due to the high fixed capital cost and declining marginal cost nature of these assets, many of these markets are naturally disposed towards monopoly or oligopolistic control, and limited competition, potentially inhibiting more efficient market outcomes.
- While performance measurement is not a substitute for competition or appropriate regulation, in cases where competition is limited, it can be used to complement or inform regulation.
- Multiple recent examples of privatisations and PPPs show that drawing conclusions on their perceived successes or shortcomings is made harder without adequate performance data.
- Moreover, aligning the incentives of private infrastructure operators and their customers, prior to privatisation or private sector procurement is within the control of governments, and should not be disregarded in favour of short-term fiscal outcomes.

4.1 Introduction

Chapter 3 highlighted that most infrastructure performance measurement frameworks in use in Australia were either developed by government agencies or as a result of government involvement. Even the performance measures used by Aurizon are formalised in its government-approved access undertaking. If Australian private sector infrastructure operators measure and monitor performance, these measures typically are not readily and publicly available.

The relationship between private infrastructure investment, customer outcomes and performance measurement is worth exploring, as it explains both why private operators may not measure, or may not publicly report, asset performance of their own volition, and why performance measurement should be considered in public sector asset procurement processes or as part of asset privatisation.

4.2 Rationale for private ownership of infrastructure

Privatisation

As noted in Chapter 1, up until the 1980s, Australian governments—Commonwealth, state and territory—owned and operated much of Australia's major infrastructure, including roads, railways, ports, airports, airlines, coastal shipping operators, electricity generation and distribution networks, water infrastructure, etc. Over the past three decades, much of Australia's public infrastructure and most infrastructure-related businesses have been privatised, often following earlier corporatisation and broader market deregulation—for example, the sale of Qantas and Australian Airlines followed deregulation of domestic aviation in 1989.[5]

Privatisation has in part been justified on the basis that private companies face stronger incentives to respond to customer demands than government-owned companies. Indeed, customer dissatisfaction with the services of state-owned firms has been one of the primary arguments in favour of privatisation (Megginson and Netter, 2001, p. 347).

This dissatisfaction extends from the weak incentives that public sector managers face. As Myers and Lacey (1996, pp. 332–333) explain,

> *"… in the public sector, the incentives facing the bureaucrat immediately providing the service to the population are usually very different [from the private sector]. Far from having a 'bottom line' which will lead him to want to satisfy the customer, his link to the customer is through a complex chain of multiple agencies which obscure rather than clarify accountability… The rewards and penalties facing the bureaucrat are unlikely to be directly related to the quality of service he provides to his customers."*

Many of these problems can continue even after governments corporatise their state-owned firms. The World Bank (1995, p. 7) found that when some governments put performance contracts in place for senior managers of public firms, they "did not improve, and in some cases exacerbated, the poor incentive structures facing government managers." Megginson and Netter (2001, p. 330) add that implicit (or explicit) state financial backing, and poorly defined and shifting corporate goals are also causes of poor performance in publicly-owned companies.

While these issues may provide a strong basis for the privatisation of publicly-owned firms operating in more competitive markets (such as the privatisation of the Commonwealth Bank, or Medibank Private), the picture is more complicated for private investment (both privatisation and PPPs) in public infrastructure, due to the monopolistic characteristics of many infrastructure markets—that is, those with high fixed capital costs and decreasing marginal costs.

Markets with these characteristics favour the provision of goods and services by a single firm. Monopoly infrastructure operators have the ability to raise prices above a level that would prevail in competitive markets and little incentive to improve services above a minimum standard of service quality, to the detriment of economic efficiency and the living standards of consumers. This outcome is an example of what is commonly referred to as *market failure* in the economics literature.

5 Corporatisation refers to the restructuring of public-sector organisations to more closely accord to that of publicly-listed companies, with commercial directorial boards, in order to introduce corporate and business management practices. Corporatisation was often a precursor to privatisation.

Perceived or actual market failure was an original justification for state ownership, along with concerns about universal access to services across rural and regional areas. However, it does not follow that governments will automatically be better infrastructure managers than their private sector counterparts. As Megginson and Netter (2001, p. 329) note, the move towards privatisation was "a response to the failings of state ownership."

To highlight this point, the World Bank (1995, p. 59) puts forward the example of a water utility:

> *"a poorly regulated private water monopoly might price clean water out of reach of many households. But a poorly managed and supervised [state-owned enterprise] may not do any better. That is, it may also provide service only to a small proportion of the population, not because of overpricing, but because its revenues have been so eroded by underpricing, overstaffing or mismanagement that it has underinvested in expansion and maintenance."*

Corporatisation did not solve all these problems in Australia. There are numerous examples in which publicly-owned companies relied, or continue to rely, on state support while ostensibly being corporatised. For example, prior to privatisation, half of Telecom Australia's annual capital expenditure was provided as a direct grant from the Australian Government (Telstra, 2011, p. 3) and Trans Australian Airlines (TAA) was shielded from competition by the *Civil Aviation Agreement Act 1957*. Even today, the state-owned Australia Post still enjoys "the exclusive right to carry letters within Australia" (*Australian Postal Corporation Act 1989* s 29(1)).

Upon reviewing the trade-offs between state and private ownership, Shleifer (1998) argues that it is easier for governments to contract away the problems of private provision than it is to solve the problems associated with state ownership.

All of these arguments were made during the major debates over privatisation in Australia in the 1980s and 1990s. The *1993 National Competition Policy Review* (the Hilmer Review) noted that the lack of "competitive neutrality" between government-owned enterprises and the private sector was a factor limiting productivity growth and broader economic efficiency in the Australian economy (Hilmer, 1993). The report also asserted that,

> *"… while trade policy reforms have markedly increased the competitiveness of the internationally traded sector, many goods and services provided by public utilities… are sheltered from international and indeed domestic competition"* (Hilmer, 1993, p. xviii).

The Competition Principles Agreement signed by COAG in 1995 sought to address many of the problems identified with state-ownership in Australia. State and territory governments pledged to corporatise many of their state-owned enterprises, and to separate their regulatory and commercial functions. New regulatory agencies, including the Independent Pricing and Regulatory Tribunal (IPART) in NSW, and the Office of the Regulator-General (now the Essential Services Commission (ESC)) in Victoria, eventually expanded to cover the economic regulation of many state services, from water pricing to taxi licensing. States also significantly restructured their electricity and gas utilities, breaking them up into retail, generation, distribution and transmission companies in order to promote competition in retail and generation markets.

The addition of Part IIIA into the *Trade Practices Act 1974* (now the *Competition* and *Consumer Act 2010*) in 1995 allowed for the creation of national third-party access agreements for nationally significant infrastructure, overseen by the ACCC, supplementing existing state-based schemes. Such agreements now underpin assets ranging from port access to freight rail.

The changes made to infrastructure markets in the wake of the Hilmer Review explain why successive Australian, state and territory governments have been willing to privatise some monopoly infrastructure assets; corporatisation and regulatory independence made privatisation simpler to execute.

Privatisation has had a net positive effect on the Australian economy. As the draft report of the 2015 *Competition Policy Review* (the Harper Review) concluded,

> *"Privatisation has brought considerable public benefit. Governments have been able to redirect resources from asset sales into, for example, human services, and retail competition has emerged in many markets. Privatisation has also delivered more efficient management of assets and investments have been more responsive to changes in market demand"* (Harper, 2015, p. 119).

The ACCC (2015, p. 3) maintains a similarly positive view:

> *"When implemented appropriately, privatisation can improve the efficiency of investment and operations in the interests of users and the general community, and to facilitate innovative management. Proceeds from the sale can also be reinvested in new infrastructure to improve the welfare of Australians."*

PPPs

The benefits of PPPs are in many ways similar to those of privatisation, namely that the participation of the private sector contributes more specialist skills, management expertise and incentives than the public sector may be able to deliver on its own. The National PPP Guidelines state that,

> *"PPPs can potentially deliver significant benefits in design and the quality of services and the cost of infrastructure… PPPs also provide the construction, service and finance industries with opportunities to generate efficiencies and cost-effectiveness in the delivery of infrastructure and non-core [government] services through innovation and specialist expertise…"* (Department of Infrastructure and Regional Development, 2016, p. 12).

These benefits are also noted by the Productivity Commission (2014, p. 114), which argues that,

> *"The private sector is likely to have specialist expertise, for example in the area of project management for large and complex projects, and hence may be better able to deliver infrastructure projects on time and to budget. Firms will often be aware, before government, of recent design and technology options that would advantage both contractor and owner if incorporated into tenders. They also have stronger incentives to reduce costs and to operate efficiently, partly driven by shareholder pressure for performance and accountability, and the incentives to pursue profit by outperforming their competitors."*

PPPs also present private sector participants with a better set of incentives than exist under traditional procurement. Under a traditional design and construct (D&C) contract, or a simple construction contract, bidders have little incentive to think about the long-term maintenance requirements of the asset. Hence, the incentive is to focus on construction cost reduction above long-term (life cycle) cost considerations. PPPs remove this perverse incentive, as the private consortium is responsible for construction and maintenance over the whole life of the asset.

Several reviews have found that PPPs perform better than D&C contracts. One review of 21 PPP projects and 33 traditionally procured projects undertaken between 2000 and 2007 found that PPPs had an average, but statistically insignificant, cost overrun of 1.2 per cent, versus a statistically significant 14.8 per cent cost overrun for D&C projects (Infrastructure Partnerships Australia, 2007). In addition, PPPs were delivered on average 3.4 per cent ahead of schedule, compared to 23 per cent behind schedule for traditional projects. A study by Duffield, Raisbeck and Xu (2008), of 25 PPPs and 42 traditionally procured projects (based on the data used in the Infrastructure Partnerships Australia study), made similar findings. The authors found that PPPs experienced an average cost overrun of 4.3 per cent, compared to 18.0 per cent for traditional projects; PPPs were delivered on average 19.4 per cent early, compared to an average delay of 25.9 per cent for traditional contracts.

4.3 Performance measurement and the design of PPPs/privatisations

While privatisation and PPPs impose private sector incentives to infrastructure, they do not automatically solve the problem at the centre of many infrastructure markets—potentially limited competition for the services provided by the infrastructure. While the initial stages of infrastructure projects are almost always open to competitive tender (whether it be to construct a PPP project or acquire a public asset), this is often the only part of an infrastructure asset's lifecycle in which market forces can be introduced. It may be decades before an asset is returned to public ownership or retendered, during which time private operators may have little incentive to deliver efficient outcomes for consumers if no other action is taken.

Regulation has long been used as the second-best alternative to competition in monopolistic infrastructure markets. Australia's NEM uses a combination of price and revenue regulation to constrain the behaviour of electricity transmission and distribution companies, which have geographic monopolies (AEMC, 2013). Toll road price increases are also fixed by contracts, with some toll prices linked to the consumer price index (CPI), and others permitted to rise at a faster rate.

Regulating prices or revenues, however, does not incentivise infrastructure operators to achieve a high level of service. It may in fact do the opposite, and encourage infrastructure operators to keep prices low at the expense of service quality. The task of identifying alternatives to pricing regulation is not a new one. Road agencies deal with a similar problem. With the majority of public roads unpriced, road agencies need alternative methods to hold themselves accountable to road users. As Chapter 3 showed, to varying degrees, road agencies are using performance measurement as an alternative form of accountability in place of either competition or pricing regulation. The logic is that where prices are fixed (either by contracts or regulation), performance measurement can be used to inform customers and other stakeholders on whether infrastructure operators are meeting service quality obligations.

By contrast, in more competitive markets, commercial viability and business profitability depend critically on best satisfying the price and quality demands of customers. In such markets, both regulation and performance measurement are superfluous: competition ensures the market best meets consumer demands and the main indicator that customers' needs are being met is if a business is profitable.

The challenge, therefore, is for governments to identify the most effective means to shape the incentives that private infrastructure operators face over the whole life of an asset. Performance frameworks, tied to customer satisfaction and financial penalties and rewards, are a promising, if relatively new and untested, alternative to traditional price regulation. The difficulty is that governments often have competing priorities when designing PPPs and privatising assets, such as time or revenue concerns, that may reduce their willingness or ability to design robust performance measurement frameworks. Some recent PPP projects have attempted to include outcomes-focussed performance criteria, aligned with delivering more flexibility for private sector providers and more efficient long-term outcomes for customers.

4.4 PPP and privatisation case studies

This section explores further the issues presented in Section 4.2 and 4.3 through five case studies of past privatisations and PPPs. It then ties together the lessons from these case studies and suggests avenues for improvement.

Telstra

Prior to privatisation, Telstra (then Telecom Australia) was the sole provider of domestic telecommunications in Australia, from network infrastructure through to retail services (PC, 2001, p. 584). The company was not required to be commercially focussed; Telecom Australia was only required by the *Telecommunication Act 1975* to generate revenue that covered its annual current expenses and half of its capital requirements. The other 50 per cent of its capital requirement was provided directly by the Australian Government (Telstra, 2011, p. 3).

Updated telecommunications legislation was passed in 1991 that paved the way for full liberalisation in 1997 with the passage of the *Telecommunications Act 1997*. The 1997 Act ended government restrictions on the number of carriers allowed to provide telephony services in Australia; removed or reduced many of the exclusive rights enjoyed by Telstra; established a telecommunications-specific third-party access regime; put in place a telecommunications-specific anti-competitive code of conduct; and tightened consumer protections, among other things (PC, 2001, p. 590).

The regulatory regime established by the two Acts was unique among nine countries surveyed by the Productivity Commission in 1998, in that it provided a formal regulatory process through which new entrants to the telecommunications market could access Telstra's existing network infrastructure on fair terms (PC, 1999, p. 75). Essentially, while Telstra still owned the copper fixed-line network and much of the existing backend infrastructure, it was forced to negotiate with other companies wanting to access or connect to this infrastructure and compete for retail customers. In addition, the price controls that were established for Telecom Australia in 1989 were to continue (CIE, 2014, p. 6). Telstra's mobile network was not subject to the same third-party access regime. By the end of June 2001, 73 companies were licensed to provide telecommunications services and operate network infrastructure throughout Australia (PC, 2001, p. 608).

Telstra's fixed-line services were also made subject to performance monitoring by the Australian Communications Authority (ACA) under section 105 of the *Telecommunications Act 1997,* monitoring that continues today with the ACMA's (2016) annual *Communications Report*.

The *Telecommunications Act 1997* (s 105(1)) gives ACMA broad discretion over how to measure the performance of telecommunications services, but specifies that it must have particular reference to consumer satisfaction, consumer benefits, and quality of service. Details of the performance measures ACMA uses can be found in Chapter 3.

Shortly after the first tranche of shares in the Telstra were floated on the Australian Securities Exchange (ASX), the Productivity Commission (1999) benchmarked the price and performance of Telstra services against that of eight comparable Organisation for Economic Cooperation and Development (OECD) countries: Japan, Sweden, France, Canada, the US, the UK, and New Zealand. On price, Australia ranked in the middle of the group on most measures. Residential fixed-line prices were nearly 30 per cent higher than in the cheapest country, while mobile phone prices were 70 per cent higher (PC, 1999, p. xxxiv). The quality of service provided to Telstra customers prior to privatisation was mixed. While customers reported high rates of satisfaction with Telstra's services (ranging from 82 per cent satisfaction with "service restoration" to 95 per cent for local, long distance and international call quality), when compared objectively against its peers international it fell short (PC, 1999, p. 161).

As shown in Tables 4.1 and 4.2, prior to privatisation Telstra compared poorly on fault repairs and answer-seizure ratios.[6] Telstra's answer-seizure ratio was only 60 per cent, 19th out of 27 OECD members, meaning four in ten international calls originating in Australia failed to connect (PC, 1999, p. 174).

Table 4.1 International comparison of Telstra's performance (fixed line), 1995

Measure	Australian ranking
Faults repaired within 24 hours	21 of 22
Answer-seizure ratios	19 of 27

Source: PC (1999).

Table 4.2 International comparison of Telstra's performance (fixed-line) against selected countries, 1997

Measure	September, 1997
Australia (Telstra only)	
• Metropolitan business faults cleared within one working day of notification	83.0%
• Metropolitan residential faults cleared within one working day of notification	54.0%
• Country faults cleared within one working day of notification	68.0%
Canada (BC TEL only)	
• Residential out of service conditions cleared within 24 hours of customer report	87.0%
• Business out of service conditions cleared within 24 hours of customer report	88.0%
• Rural out of service conditions cleared within 24 hours of customer report	74.0%
New Zealand (Telecom NZ only)	
• Faults cleared within 24 hours (March, 1997)	60.0%
United Kingdom (British Telecom only)	
• Business faults cleared in five working hours or by successful appointment	88.8%
• Residential faults cleared in nine working hours or by successful appointment	81.9%

Source: PC (1999).

6 A measure of the proportion of international calls that are connected to their destination.

Fast forward to 2017 and the service Australians are receiving from Telstra on their fixed-lines has improved, as shown in Table 4.3. Residential faults restored within 24 hours have improved from around 54 per cent in 1998, to 93.4 per cent in 2014–15.

The fixed-line network, however, has not delivered Australians universally good broadband services. In 2014, the latest year for which figures are available, Australia had the third-lowest median advertised fixed-line broadband speeds in the OECD, and by one measure, the 8th most expensive (OECD 2015a, 2015b). Part of the reason for this may be the disincentives Telstra faces when deciding to upgrade the fixed-line network. The third-party access regime means that Telstra gains little advantage from investing in the network, as other operators will also have access to and be able to offer these improvements to customers as well.

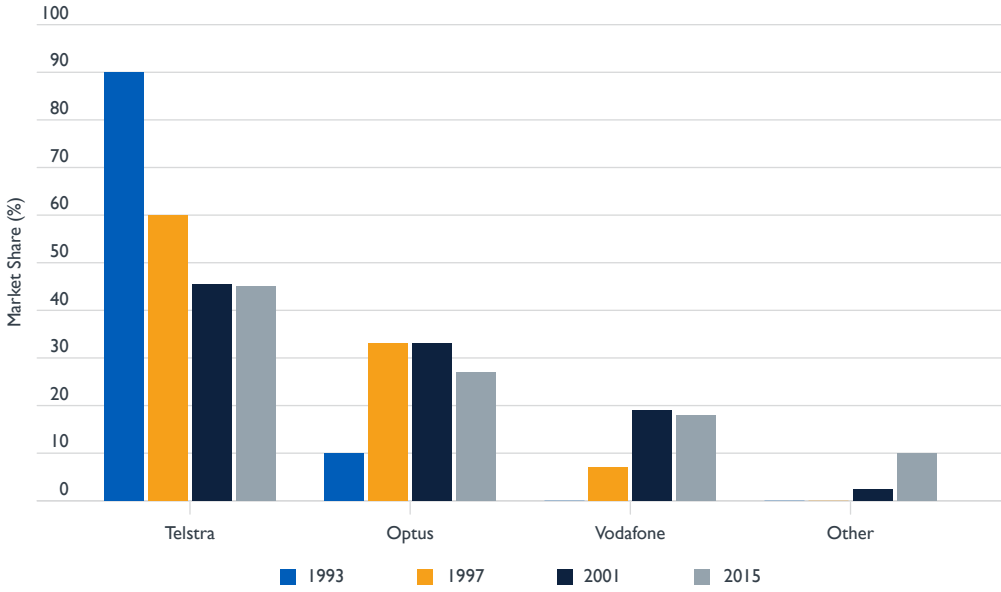
Table 4.3 Telstra performance (fixed-line), 1998 and 2015–16

Service	March quarter, 1998	2015–16
Customers connected to new services on time	74% (all areas)	90.9% (urban areas) 92.9% (minor rural areas) 92.6% (remote areas)
Customer connected to in-place services on time	92% (all areas)	94.3% (all areas)
Faults restored within 24 hours	54% (urban areas)	91.5% (urban areas)

Source: PC (1999) and ACMA (2016).

In mobile telephony, the outcomes achieved by the liberalised market have been better, in both absolute terms and relative to other countries. Australia now has the 6th most affordable mobile phone services in the now 35-member OECD, and the 6th fastest mobile download speeds (ITU, 2016, p. 107; OpenSignal, 2016). And between 1997–98 and 2014–15, the price of mobile phone services more than halved in Australia in real terms, while the average monthly mobile data allowance almost tripled between 2011–12 and 2015–16; both signs of strong competition in the mobile and wireless markets (ACCC, 2016b, p. 87). Figure 4.1 shows how competition has affected Telstra's market share over time.

Figure 4.1 Retail market share for mobile handset services, select years



Source: PC (2001), ACCC (2001), ACCC (2016b) and Kain (1997).

While services in both mobile/wireless and fixed-line markets have improved, the mobile/wireless market has improved at a far greater pace. Competition appears to be a significant difference between the two markets. Three mobile network operators (MNOs) operate in Australia: Telstra (98 per cent population coverage), Optus (95 per cent population coverage), and Vodafone (96 per cent population coverage) (ACMA, 2016, p. 20). Strong competition for retail customers between the three has driven the previously described improvements in the services they offer to Australians. By contrast, there are no significant competitors to Telstra's fixed-line network, through which internet services are carried. Combined with the requirement for Telstra to make its fixed-line network available for use by other providers, there was little competitive pressure for Telstra to improve its services. A plan for Telstra to invest $3 billion in replacing its copper network with a fibre-to-the-node network was withdrawn in 2006 after disagreements with the ACCC over the access price Telstra would be able to charge third-party providers (ACCC 2006a, 2006b). In 2009, the Australian Government (Conroy, 2006, p. 47) established the government-owned National Broadband Network Company (NBN Co.) to replace the whole national copper network, explicitly acknowledging that the poor broadband services Australians received was, in part, the result of the,

> *"lack of incentive to invest and difficulties in competing given the structure of the telecommunications industry, particularly as Telstra was privatised without an effective competition framework being put in place."*

The case of Telstra's privatisation and regulation illustrates that performance measurement is not a substitute for well-designed markets and competition. It is somewhat ironic, but entirely understandable, that the fixed-line market, which the *Telecommunications Act 1997* places most importance on for performance measurement, has performed worse for consumers than has the less regulated, less monitored mobile/wireless market.

Transmission Gully Project

The Transmission Gully Project (TGP) is New Zealand's first road project delivered through a PPP model. The TGP is a 27-kilometre motorway between MacKays and Linden, via Transmission Gully, just north of Wellington on the North Island. This is a significant project for the NZTA, the statutory entity responsible for land transport in New Zealand. Previously, NZTA was responsible for all aspects of planning, funding, and operating the 11 000 kilometres of roads on the state highway network using traditional public procurement models. The TGP will see NZTA take on an additional role of overseeing the 25-year lease of the road when it is completed by 2020 (NZTA, 2017).

NZTA's decision to utilise a PPP delivery model was based on cost-benefit analysis, and on criteria set out by the New Zealand Treasury (NZTA, 2012a, p. 4; NZTA, 2012b, p. 2; NZ Treasury, 2015):

- Private sector involvement will deliver the same project more cheaply than NZTA could using its existing procurement methods.
- A PPP provides an opportunity for NZTA "to learn new and innovative approaches to procurement, design, operation and risk management, and apply these across the wider network, lifting the value of the NZ Transport Agency's overall investment."
- The NZ$1 billion in funding previously ear-marked for Transmission Gully can be used to bring forward other projects.

It is important to note that there are currently no plans to impose tolls on the TGP; however, NZTA (2012c, p. 71) says that there is the option to do so in future.

What makes the TGP unique (at least when compared to most Australian road PPPs) is that the contract to a large degree specifies only the outcomes the project should achieve, rather than inputs or activities that the private contractor must undertake. The contract goes so far as to call these "overriding outcomes", which direct the contractor to ensure that the TGP is designed and constructed:

- to enable the service requirements to be delivered;
- to produce high and sustained safety outcomes (reduction in deaths and serious injuries) and to permit continuous safety improvements, which achieve and maintain no less than a four star KiwiRAP rating;[7]
- to reduce travel time from MacKays Crossing to Linden;
- to improve travel time reliability from MacKays Crossing to Linden;
- to ensure high and sustained customer satisfaction (including through amenity and environmental factors) and customer service; and
- to provide a secure connection between Wellington and the north, able to be quickly restored following any disruptive flood or seismic event. (NZTA, 2014a, p. 15)

Similarly, many of the requirements relating to maintenance and operation of the TGP direct the contractor to ensure that service outcomes are met, including that the road surface last a minimum number of years before requiring replacement. The contract even stipulates that the contractor's asset management framework be flexible and that it "ensures continuous

7 KiwiRAP is the New Zealand Road Assessment Programme, which analyses the road safety of the state highway network.

improvement in asset management performance" (NZTA, 2014b, p. 7). The TGP envisages change as a feature of the contract between NZTA and the contractor; in particular, there are numerous references in NZTA documentation to the ability of the contract to *innovate and make improvements* [emphasis added] to the road as it sees fit (see NZTA, 2012b; NZTA, 2012c).

At 25 years, the TGP contract is also of shorter duration than many Australian road PPP projects, which typically have 30 to 50 year concessions (NZTA, 2012c, p. 59; NSW Treasury, 2017).

Two additional features of the TGP underpin this outcomes-based approach: the type of PPP model that NZTA has chosen, and the performance framework included in the TGP contract.

NZTA's chosen model of PPP relies on a financing mechanism whereby the private contract finances the construction of the TGP upfront, with NZTA providing a quarterly availability payment once the TGP is open. To ensure that the contractor, free from patronage/revenue risk, maintains the road at a good standard, NZTA's performance regime penalises the contractor if pre-agreed performance standards are not met by reducing its monthly payment. This combination of availability payments based on asset performance is the standard PPP model used in New Zealand (NZ Treasury, 2015, p. 1).

Two of the performance standards written in the TGP contract directly relate to customer satisfaction. The first penalises the contractor if six-monthly user satisfaction survey results are below an initial baseline (to be determined by two initial surveys) (NZTA, 2014c, p. 44). The second customer satisfaction-related performance measure relates to public complaints. Under the TGP contract, the contractor is charged a set amount per day for each day a request, enquiry or complaint from the public was received and not responded to appropriately within five days (NZTA, 2014c, p. 45). To avoid gaming, the contract also specifies what an "appropriate" response is.

The exact size of the penalties for these measures, and the 14 others in the contract, is currently commercial-in-confidence. Daley (2015), who led a financing team at one of the banks with an equity stake in the TGP, said that such a performance regime was "new territory" for the TGP's investors, and that the transfer of safety, environmental and customer satisfaction risk onto equity investors were not risks "the banks were used to seeing". Equity investors ultimately demanded caps on the size of charges in any given year, although the caps are far above what NZTA or the TGP equity investors think would ever be relevant (Daley, 2015).

Reviewing the performance regime in relation to safety, Daley (2015) concludes that the intent of the TGP is clear, if still unproven until the road is completed:

> *"to provide alignment, and incentive, for all parties to ensure safety. If the owners of the road are liable for charges for a death or serious injury, indeed higher charges if there are repeat occurrences, then there is incentive for them to re-invest in the road if that is necessary."*

This is applicable to all of the performance measures in the TGP contract.

The Peninsula Link freeway in Melbourne operates on a similar model to the TGP, in that it uses availability payments linked to a performance framework, however, it does not go so far as to measure customer satisfaction directly. Quarterly performance indicator results for the Peninsula Link are not publicly available.

Lane Cove Tunnel

The Lane Cove Tunnel (LCT) is a 3.6km tunnel on Sydney's lower north shore, connecting the Hills M2 Motorway and the Gore Hill Freeway. Construction was completed in 2007.

The LCT is structured as a build, operate, transfer (BOT) PPP, the same as the TGP, with the crucial difference being the funding model used. Whereas the TGP is to be funded using availability payments from NZTA, the LCT was entirely privately funded at no financial cost to the NSW Government (RTA, 2010a, p. 5). The LCT thus shifted patronage risk to the tunnel's owner, Connector Motorways, along with finance, funding, and the majority of construction and operational risks. The only risks held by the NSW Government were land acquisition and integrating the LCT with the road network (RTA, 2010a, p. 6).

A summary of its terms (the full contract is not publicly available) shows that the LCT contract provides little flexibility for either the operator or the NSW Government (RTA, 2010b). For example, any change proposed by the then Roads and Traffic Authority (RTA, now RMS) were to be made on the condition that "the change would not or will not adversely affect the use, patronage or capacity of the motorway or [the owner's] ability to levy or collect tolls" (RTA, 2010b, p. 30).

A further indicator of the inflexibility of the LCT contract is that conditions relating to changing the scope of the project are solely contained within the design and construction section of the contract, whereas in the TGP contract, "changes" are a separate section and allow for changes post-construction (NZTA, 2014d, p. 158). The RTA (2010b, p. 41) states that "There are no equivalent procedural or cost/benefit-sharing provisions in the Project Deed concerning changes to the scope of operation, maintenance and repair and/or asset renewal obligations which do not arise out of changes to the project's design and construction works." Essentially, there is no incentive for the RTA and the tunnel owner to work together to improve the quality of service of the LCT now that it is open to traffic. The RTA (2010a, p. 27) acknowledged in a post-implementation review of the project that a weakness of the LCT was the "limited flexibility to modify key project elements as design develops."

Both the funding model of the LCT and the inflexibility of the contract led to perverse outcomes for road users.

The transfer of patronage risk to Connector Motorways meant that the RTA had to give the company substantial concessions to build confidence that motorists would use the tunnel. One concession was the decision to close nearby surface roads. Epping Road, the major surface road that runs above the LCT, was reconfigured as part of stage two of the LCT project. Originally a six-lane road (three lanes in each direction) prior to the tunnel's construction, one lane was converted into a bicycle and pedestrian path, and another turned into a 24-hour bus lane, effectively reducing the road to one lane in each direction for non-bus traffic. Public backlash to these changes was large enough that the NSW Government delayed stage two surface works for 11 months, at a cost of $25 million to NSW taxpayers (Connector Motorways, 2007; Phillips, 2007a, p. 5).

The second concession has already been mentioned above, namely that RMS cannot do anything that adversely affects patronage of the tunnel. The contract states if any of 12 specified (though not actually listed in the contract summary) traffic connections to the motorway are closed or "materially reduced", the contractor has the right to renegotiate the entire contract with RMS (RTA, 2010b, p. 57).

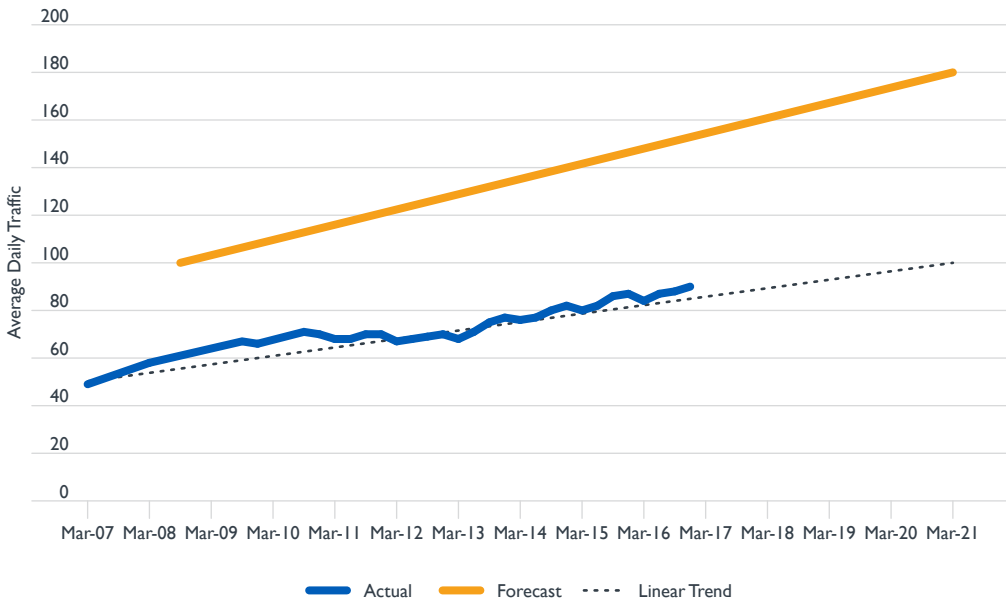
Neither concession is to the benefit of road users. Phillips (2007b, p. 19; 2007a, p. 6) argues that the financial viability of the LCT is based on "inconveniencing motorists," and that the closure of lanes on Epping Roads meant that the only additional road capacity added by the tunnel were the dedicated bus lanes. He concludes,

> *"It is hard to see how one bus lane each way for two kilometres could be worth over a billion dollars"* (Phillips, 2007a, p. 8).

The restriction on RMS doing anything that may negatively affect usage of the LCT prevents the agency from improving surface road capacity in and around the tunnel. Its incentive to do so, however, is dampened by the fact that under the LCT contract, RMS is entitled to a portion of toll revenue if revenue exceeds forecasts (RTA, 2010b, p. 44). As it turned out, patronage was half of what was forecast, at around 56 000 vehicles per day by 2008 (Rochfort, 2008). Connector Motorways went bankrupt in 2010, unable to service its debts (Connector Motorways, 2010; Moody's Investors Service, 2009). Moreover, Figure 4.2 shows that traffic through the tunnel still has not reached the originally forecast levels, and looks unlikely to do so for some time.

Beyond the quarterly average daily traffic figures for the tunnel published by Transurban, the current owner of the LCT, no other data on its performance is published by either Transurban or RMS. The LCT, like all road projects, has impacts on the performance of the wider road network. Road users would have benefited from performance data measuring the impact of the LCT project on the surrounding road network, including impact of the surface road changes on motorists using Epping Road.

Figure 4.2 Lane Cove Tunnel actual and forecast average daily traffic, 2007–2021



Source: Adapted from Transurban quarterly traffic and revenue data, Transurban (2010), SKM (2001).

NorthConnex

NorthConnex is a 9-kilometre tunnel in Sydney's north that will link the M2 Motorway and the M1 Pacific Motorway when completed in 2019. The project was proposed in 2012 by Transurban, the operator of six of Sydney's toll roads, under the NSW Government's unsolicited proposals framework. The lack of a motorway connection between the M1 and Sydney's orbital network of motorways has been noted for some time. NorthConnex is being built on a corridor that was first identified in 2004 in a study commissioned by the Australian Government (SKM, 2004).

Several notable changes have been made to the PPP process in NSW since the LCT. The NSW Government now has a public interest evaluation for all PPP projects, which was applied to NorthConnex (NSW Treasury, 2012). The entire project deed and schedules for NorthConnex are publicly available. The NorthConnex project deed allows for both RMS and the private operator to propose changes to the road once construction is complete and share the costs and savings, subject to agreement (Clayton Utz, 2015).

NorthConnex, however, raises questions about the long-term impact of toll roads on broader network efficiency. As part of the deal to fund NorthConnex, the NSW Government agreed to extend Transurban's concession on the LCT by 11.5 years, the Westlink M7 Motorway by 11.4 years, and the Hills M2 Motorway by 2.1 years (Transurban, 2015, p. 10). Transurban has also been permitted to raise the toll multiplier for trucks from two times to three times on the LCT and from one to three times on the Westlink M7 Motorway over the next two years (Transurban, 2015, p. 10). The NSW Government also agreed to direct trucks from Pennant Hills Road (the main surface road above the NorthConnex tunnels) into the NorthConnex tunnels through "regulatory measures", which are yet to be finalised but "may include a fine for trucks using Pennant Hills Road when they do not have a local destination" (NorthConnex, 2017).

This is not the first time new toll roads have been partially funded by extensions to the concessions of older toll roads. The concession on Transurban's CityLink in Melbourne has had two contract extensions to pay for new construction, while the Hills M2 Motorway has previously been extended to pay for additional lanes in each direction.

If the trend continues, state road agencies will be restricted from making changes to large parts of the road network for far longer than was anticipated at the time each toll road PPP was finalised.

There are also competition issues to consider. Transurban, as the owner of six toll roads in Sydney, six in Melbourne, and three in Brisbane, has a competitive advantage over rivals in that it can use its existing toll road concessions to reduce the upfront cost to governments of new toll roads. NorthConnex, for example, may have required more state and federal funding had Transurban been unable to leverage its existing concessions in negotiations. This also means that its competitors are at a significant disadvantage in making unsolicited proposals. Indeed, to date, all toll road projects in Australia that have been approved through state and territory unsolicited proposal frameworks have been proposed by either Transurban or its subsidiaries:

- CityLink – Tulla Widening (Melbourne)
- Western Distributor (Melbourne)
- NorthConnex (Sydney)
- Logan Motorway Enhancement Project (Brisbane)

The effect of the expanding network of toll roads on the broader efficiency of the road networks in Australian cities is unknown, again because no performance data is published. This problem will continue and become more acute as more toll roads are constructed. A lack of information on the performance of major arterial roads in Australia's cities reduces the ability of motorists to measure the value of the service for which they pay.

Port privatisation in NSW

Between 2012 and 2014, the NSW Government privatised the state's three largest ports: Port Kembla, Port Botany, and the Port of Newcastle.

Port Botany is the second-largest container terminal in Australia, handling approximately 2.3 million twenty-foot equivalent unit (TEU) containers in 2015–16 (NSW Ports, 2016a, p. 4). Port Kembla handles few containers, but is Australia's largest vehicle import terminal, one of the largest export grain terminals, and is the second largest coal export terminal in New South Wales (NSW Ports, 2016b). The Port of Newcastle is the world's largest coal export port, handling in excess of 167 million tonnes of trade in 2016, 96 per cent of which was coal exports (Port of Newcastle 2017a; 2017b, p. 1).

Port Botany and Port Kembla

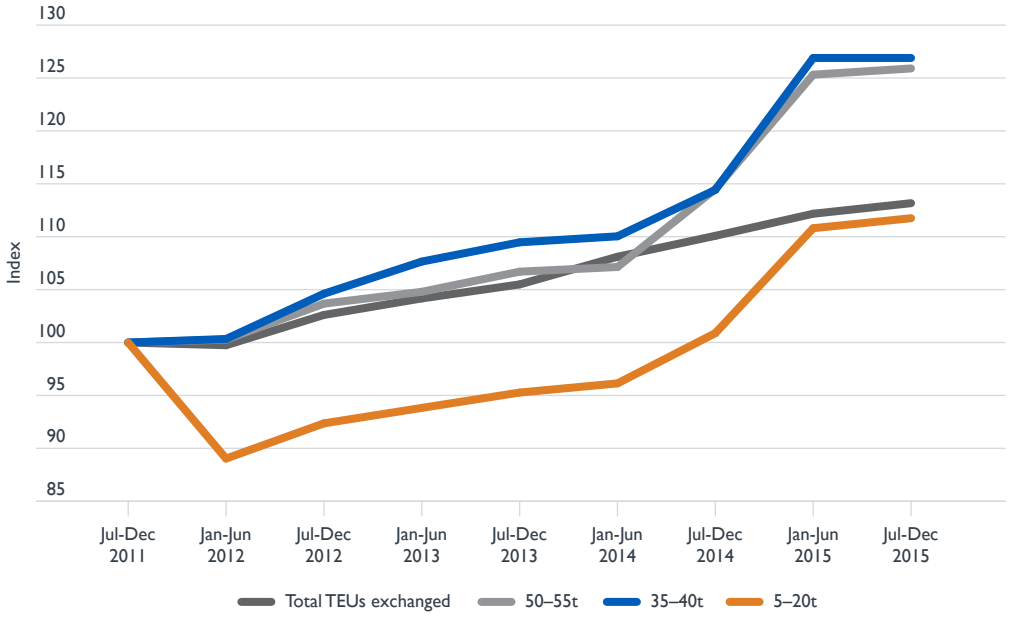
In May 2013, Port Kembla and Port Botany were privatised together in a single 99-year lease, raising $5.0 billion for the NSW Government (AONSW, 2013, p. 7).

Post-privatisation, the ports are not subject to an access regime, or to any economic regulation, except a NSW Government-imposed "light-handed price monitoring regime" (NSW Treasury, 2015, p. 7). The framework (contained in Part 6 of the *Ports and Maritime Administration Act 1995* (NSW)) stipulates that port operators have an obligation to publish a list of their fees and charges, inform the Minister annually of its fees and charges, and give advance notice of changes to its fees and charges (NSW Treasury, 2015, pp. 9-10). No government agency, state or federal, has the authority to review or challenge changes to fees and charges, barring a declaration under the National Access Regime. The NSW price-monitoring regime does not require NSW Ports, the private port operator, to negotiate with port users before price changes are decided.

In addition, it came to light in 2016 that the NSW Government made "contractual commitments to the private Port Lessee of Port Botany and Port Kembla to make certain payments to NSW Ports in respect of future container capacity development at the Port of Newcastle" (NSW Government, n.d., p. 1). In practice, this means that the NSW Government will charge the Port of Newcastle for each TEU above 30 000 TEU (per year) that moves in or out of the port, and pass this money on to NSW Ports. It has been claimed that the charge could amount up to $1 million per container vessel (NSW, Legislative Council, 2016, p. 20). A charge of this magnitude would exceed the wharfage charged by the Port of Newcastle on even the largest container ship to ever dock in Australia (Port of Newcastle, 2016a, p. 4; NSW Ports, 2016c).

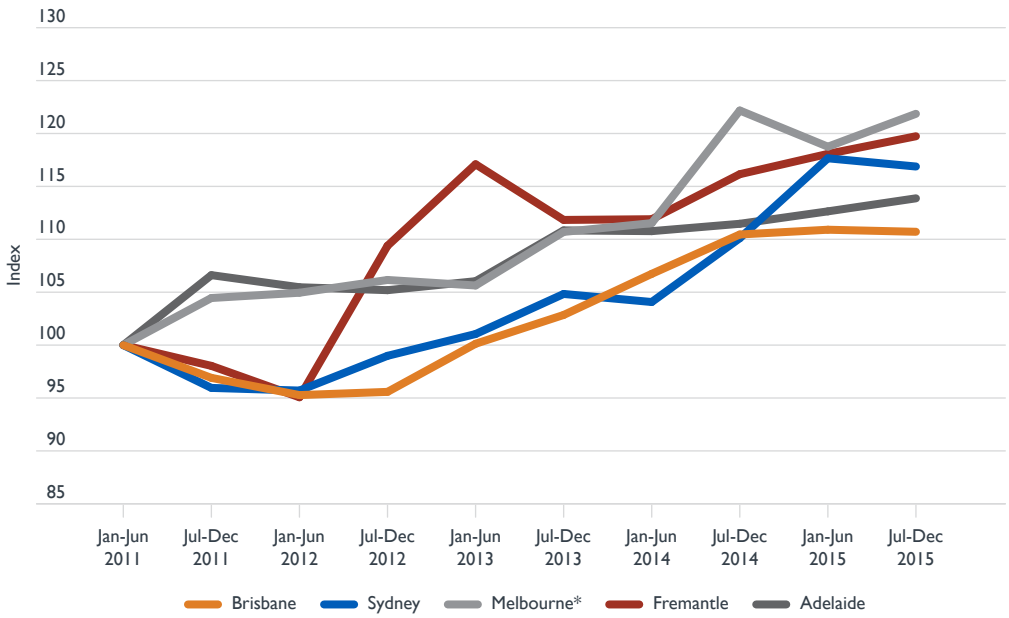
Since privatisation in 2013, charges levied by the port operator at Port Botany and Port Kembla have outpaced the growth in the number of shipping containers being handled at the two ports, as shown in Figure 4.3. Prices for services at Port Botany and Port Kembla have also increased faster than those at Australia's other large container ports since privatisation, as shown in Figure 4.4.

Figure 4.3 Port Botany and Port Kembla total ship-based charges index by gross tonnage, and total TEUs exchanged, 2011–2015



Source: BITRE (2014, 2016).

Figure 4.4 Volume adjusted total ship-based charges index at select ports, 2011–2015

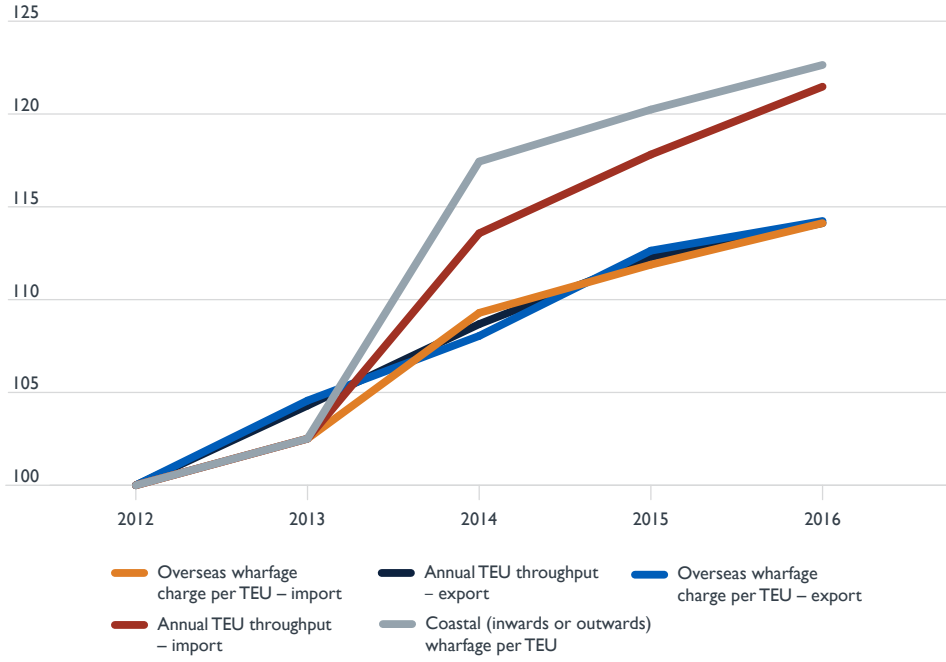


* Excludes increase attributable to $75 million annual Port License Fee imposed by the Victorian Government in 2012

Source: BITRE (2014, 2016).

Using more detailed data on port charges, Figure 4.5 shows that while the wharfage charge for imported containers has kept pace with the growth of import container movements, the wharfage charge for export containers has outpaced it. Similarly, the wharfage charge for coastal shipments has also outpaced the growth in related container movements. This outcome is not unexpected, as ports will have some degree of pricing power within their local area. The added cost of moving goods to the Port of Melbourne instead of Port Botany is high, so exporters have few options but to accept higher port charges from Port Botany. It is a similar story with coastal shipments: containerised goods destined for Sydney have few viable alternatives but to dock at Port Botany. Not included in Figure 4.5 is the wharfage charge for transhipments, which rose by more than 250 per cent between 2015 and 2016 (NSW Ports, 2015; NSW Ports, 2016d).

Figure 4.5 Port Botany select charges and annual TEU throughput, 2012–2016



Source: Sydney Ports Corporation (2012), NSW Ports (2013, 2014, 2015, 2016d) and BITRE estimates.

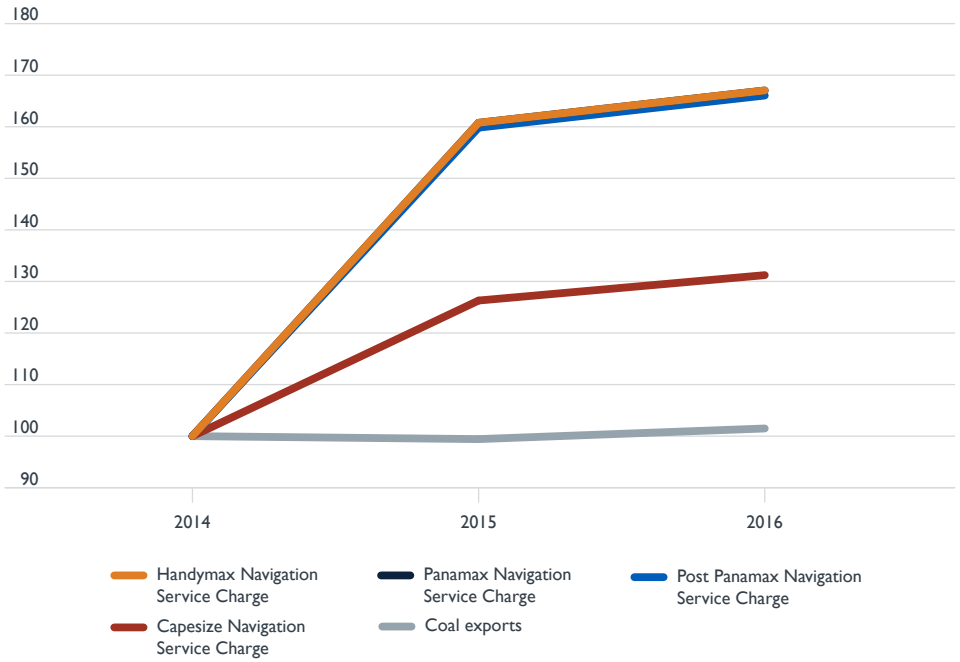
It appears that future price rises may have been factored into the sale price of the ports. In the early stages of planning, then-Premier Mike Baird (NSW, Legislative Assembly, 2012, p. 15939) stated that the privatisation would raise $2.5 billion. The final sale price six months later was gross $5.0 billion (AONSW, 2013, p. 7).

Port of Newcastle

In May 2014, the Port of Newcastle was privatised in a 98-year lease for gross $1.8 billion (AONSW, 2014, p. 41).

Like Port Kembla and Port Botany, the Port of Newcastle is subject to no economic regulation (NSW Treasury, 2015). Following privatisation, as happened with Port Botany, prices charged by the private port operator significantly increased. For example, port charges for an average vessel carrying an average load of coal rose 39 per cent between 2014 and 2015 (and up to 60 per cent for some vessel classes), while total coal exports declined slightly for the year (Port of Newcastle, 2015a, p. 69; Port of Newcastle, 2015b, p. 4; Port of Newcastle, 2016b, p. 3). Figure 4.6 shows that prices continued to rise above the rate of export growth between 2015 and 2016.

Figure 4.6 Port of Newcastle navigation service charges for select vessel types and coal export index, 2014–2016



Source: Glencore (2015b), Port of Newcastle (2015b), Port of Newcastle, (2016b) and BITRE estimates.

In response, Glencore, a major exporter of coal from the Hunter Valley, submitted an application to the National Competition Council in 2015 to have the Port of Newcastle declared under Part IIIA of the *Competition and Consumer Act 2010*.[8] In its submission, Glencore (2015a, p. 14) asserted that,

> *"the price increases are not associated with or offset by any increase in productivity, efficiency or service to be provided by the [port operator], and nor are they required for the purpose of funding any further investment."*

Shipping Australia Limited (2015, p. 2), the peak shipowner association representing businesses responsible for 80 per cent of Australia's international trade, argued that the price rises were "clear evidence of price gouging by the new operator."

Following the National Competition Council's rejection of its application, Glencore successfully appealed the decision in front of the Australian Competition Tribunal, which decided that the port should be declared under Part IIIA (NCC, 2015; NCC, 2016). The Tribunal found that, consistent with Glencore's assertions, "price increases were not accompanied by any change in the nature or quality of the Service,"[9] and that "price increases were imposed by [the Port of Newcastle] without significant consultation with users of the Service." Rod Sims (2016, cited in Keen, 2016), chairman of the ACCC, later said that this was a "great decision in the sense that it recognises that simply price monitoring a monopoly is essentially useless". It should be noted that the Tribunal's decision did not rest on arguments about price. Part IIIA's provisions are limited to disputes over access, and are silent on issues of pricing. As the NCC (2015, p. 13) notes,

> *"Declaration under the National Access Regime is not a mechanism for imposition of price regulation and was never intended to be such. "Excessive", "monopolistic" or "gouging" pricing per se is not the focus of IIIA."*

The NCC (2015, p. 15) acknowledges, however, that there is precedent for Part IIIA declarations indirectly being used to resolve pricing disputes, and that "price and future price uncertainty certainly appears at the core of Glencore's concerns".

The Port of Newcastle appealed the decision of the Australian Competition Tribunal, arguing that Glencore faced no access restrictions at the port, and further, that the price increases were "a once-off restructure and realignment of prices at the Port following more than 20 years of substantial under recovery" (Port of Newcastle, 2015a, p.1).[10] On 16 August 2017, the Federal Court of Australia ruled in favour of Glencore based on a narrow interpretation of the provisions of Part IIIA. The Port of Newcastle is yet to decide whether to appeal the case to the High Court.

As with the Port Kembla and Port Botany transaction, it appears that the terms of the privatisation significantly raised the sale price of the Port of Newcastle. It was widely reported in 2013 that the NSW Government expected to raise $700 million from the sale, but as

8 Part IIIA of the *Competition and Consumer Act 2010,* also known as the National Access Regime, "establishes a legal regime to facilitate third-party access to certain services provided by means of significant infrastructure facilities," including terms and conditions on which the service provider will offer access, and/or dispute resolution processes in the event that parties cannot agree (ACCC, 2017).

9 *Application by Glencore Coal Pty Ltd* [2016] ACompT 6 at [16].

10 The Port of Newcastle had a net profit margin of 18.3 per cent over the seven full years prior to privatisation. Until privatisation, real port charges had fallen by more than half since 1991, while nominal port charges had remained relatively unchanged since 1998; the increase in charges since privatisation has raised them to their highest real level since 2000, and highest nominal level since 1994 (Port of Newcastle, 2015a, p. 9).

previously mentioned the final sale price was gross $1.8 billion (Patty, 2013). The Australian Competition Tribunal heard that the Port of Newcastle had revised up the port's valuation to $2.4 billion.[11]

Sims (2016 cited in Potter, 2016) said that lack of pricing regulation was leading to,

> *"lovely headlines in the Financial Review saying 'gosh what successful sales, look at the multiples [of annual revenue] they achieved'. Of course they bloody well did. The owners have factored in very large price rises because there's no regulation of how they set the prices of a monopoly. How dopey is that?"*

He urged governments to stop attempting to maximise sale proceeds at the expense of long run economic efficiency (Sims, 2016 cited in Keen, 2016).

If done without economic efficiency as the primary objective, asset privatisation can increase costs to large segments of the economy, especially those of exporters. Price increases will eventually flow through to the goods bought by consumers. Without adequate attention paid to market structure and the appropriate regulatory framework, privatisations can lead to poor customer outcomes.

The picture is clouded by the lack of data on the performance of services provided by both NSW Ports and the Port of Newcastle. It is telling that in its response to Glencore's application to have the Port of Newcastle declared, the Port of Newcastle (2015a) did not mention the quality of service it offers its customers, or on any future improvements to service quality. The Port of Newcastle (2015a, p. 63) did, however, compare its price-monitoring requirement to the ACCC's *Airport Monitoring Report,* but neglected to mention the *Airport Monitoring Report* is far more comprehensive and detailed than the "light-handed regime" to which the Port of Newcastle (and Port Botany and Port Kembla) is subject.

4.5 Concluding remarks and lessons

The case studies presented in Section 4.4 provide a broad overview of the issues surrounding infrastructure privatisation and PPPs, and performance measurement.

Making judgements about the success or otherwise of individual PPPs and privatisations is difficult without sufficiently-detailed performance information. AMCA's *Communications Report* includes information on several aspects of telecommunications service quality, including price, speed, coverage, usage allowances, as well as customer surveys of service quality aspects. Combined with international comparisons, such data allows the public and governments to decide if the telecommunications market is serving customers well. By contrast, debate on the merits of toll roads, such as the LCT and NorthConnex, and the privatisation of ports in NSW is only based on publicly-available information on the contract terms, the public statements of interested parties, and single data points such as price or traffic volumes. A lack of data collected before and after the completion of PPPs and asset privatisations means that proper evaluations are difficult to conduct.

Aligning the incentives of private infrastructure operators and their customers is a goal that governments can actively pursue. The TGP shows that private operators are willing to be held financially accountable for customers' satisfaction with the assets they control, as well as safety

11 *Application by Glencore Coal Pty Ltd* [2016] ACompT 6 at [12].

and other aspects of service quality, although the framework remains untested. At a minimum, requirements to collect performance data can be included in the contracts underpinning PPPs, just as data requirements have been included in many privatisations undertaken by the Australian Government.

A second, broader lesson is that performance measurement is not a substitute for sound market design and appropriate economic regulation. The history of fixed-line broadband in Australia, following the privatisation of Telstra, shows that even when performance is monitored, poor incentives lead to poor outcomes for customers. Performance monitoring by itself cannot shape the behaviour of private operators. As Sims (2016) states, "when government assets are sold off, unless they face competition, there needs to be effective regulation… In the absence of competition, merely monitoring prices makes little to no difference. Price monitoring does not amount to regulation."

CHAPTER 5

Towards a framework for measuring infrastructure performance

Summary

- The proposed infrastructure performance and customer satisfaction framework is a first step towards creating a performance measurement framework that can be applied across different infrastructure asset types.
- The framework benefits from simplicity and flexibility, while suffers from several methodological problems that are ongoing issues for performance and customer satisfaction measurement in general.
- Data collection and performance measurement methodologies across operators in the same infrastructure sector should be harmonised to make best use of the framework.

5.1 Introduction

The previous three chapters have provided an overview of theoretical approaches to measuring customer satisfaction and infrastructure performance, and a stocktake of existing performance measurement frameworks in use in Australia and elsewhere. Chapter 4 highlighted the scope and limitations of performance measurement in informing regulation and efficient market outcomes, and the opportunities for governments' to embed performance measurement as standard practice in private infrastructure provision.

This chapter attempts to build on those learnings by developing a consistent and general framework for comparing performance and incorporating customer satisfaction across different infrastructure asset types.

The proposed framework is based on the disaggregate, performance-only approach, discussed in Chapter 2.

The broad principles underpinning the framework are that it be reasonably high level, comprehensive, applicable across all infrastructure asset types, and able to accommodate a range of different measures, while informing decision makers and market participants about the efficiency and effectiveness of infrastructure asset services.

5.2 Components of the framework

Service quality attributes

BITRE has identified seven ways in which customers interact with and judge the level of service of infrastructure. These attributes are all repeatedly mentioned in the literature, and are currently used in many existing performance frameworks referenced in Chapter 3. The seven service quality attributes are:

- Price (cost) – what customers must pay to access an infrastructure asset or service.
- Accessibility/availability – the degree to which an infrastructure service is accessible by its customers or potential customers, either as a result of its coverage, its proximity to other forms of infrastructure, and/or the frequency, and/or class of service (if applicable).[12]
- Timeliness – the average infrastructure service delivery time.
- Reliability – the degree to which an infrastructure asset's availability varies, including the variability in the timeliness (standard deviation) of services.
- Safety – typically measured by the number of casualties and/or safety-related incidents associated with the infrastructure asset.
- User amenity – the quality of an infrastructure asset, including the presence of desirable additional features.
- Information – the availability to consumers of timely and up-to-date information on the status of the preceding service quality attributes.

Supplementary measures

Several further measures are frequently of great interest to governments and policy makers, if not to customers, and are often essential to gauging the operational efficiency of infrastructure services. These include:

- Activity (use) – the number of users (for example, passengers, freight volume, vehicles or other relevant metric) of the infrastructure over a period of time.
- Capacity – the capacity of the infrastructure or service in terms of either throughput per unit time and/or maximum storage capacity at any point in time (where applicable).

These supplementary measures provide indicators of infrastructure service output, rather than service outcomes encapsulated by the seven service quality attributes.

Several additional measures can be derived from these and other data sources, including:

- Capacity utilisation – a measure of the margin to accommodate additional utilisation derived from measures of activity and capacity. (The ACCC's *Airport Monitoring Report,*

12 Class of service is relevant for when there are multiple classes of product in the same infrastructure asset category, which is particularly relevant for telecommunications services. For example, accessibility for mobile telecommunications services may relate to the coverage of 4G signal in a particular area., and customer's perception of the availability of 4G signal in that area. Ratings of telecommunication service speed may be covered in either the Timeliness service quality attribute, or the Reliability service quality attribute, depending on the performance measure available and in the phrasing of customer perception questions.

for example, captures and reports capacity utilisation measures across several aspects of airport operations.)

- Productivity – the level of output (throughput) per unit of input. (See Box 5.1 for further discussion)

The infrastructure performance and customer satisfaction framework presented here purposely excludes such derived measures, as they are less directly related to customer satisfaction and performance outcomes (see Box 5.1).

Box 5.1 Productivity

Productivity, at a basic level, is a measure of the rate at which inputs (labour, capital and intermediate goods) are transformed into outputs. A business that is able to produce more of its products with the same amount of labour, capital and/or intermediate goods, is improving its productivity. Policy makers focus on productivity because, in developed economies, improved productivity is the largest driver of income and GDP growth, as well as a measure of competitiveness of trade-exposed industries.

In the infrastructure sector, higher productivity can take many forms. For a train operator, it may mean changing processes and systems to allow more trains to run more frequently during peak hours. For a power station, it might mean sourcing coal (an intermediate input) with a higher heat content to produce more energy for the same amount of coal. The move to online billing/account systems has enabled infrastructure businesses to reduce the amount of resources, namely labour, devoted to handle these activities.

While productivity is important, it has not been included in the infrastructure performance and customer satisfaction framework for several reasons. Most notably, productivity has little direct impact on customer satisfaction. Productivity does not, *ceteris paribus,* affect the frequency, reliability or timeliness of an infrastructure service. A port may have high productivity, but it can be severely capacity constrained at the same time. Moreover, customers have little knowledge, or even interest in, the ratio of inputs to outputs of the infrastructure services they consume, thus they are not well-placed to judge the impact that productivity has on service quality. The notable exception to this may be cost—higher productivity reduces the unit cost of production. The extent to which consumers benefit from improved productivity, however, depends on the nature of the individual market—in more competitive markets, productivity gains are more likely to be passed on through lower prices, whereas in markets with fewer competitors, a greater share of the productivity benefits may be retained by producers.

Additionally, the design of the framework has deliberately been focussed on customer-side measures of market performance outcomes and customer satisfaction, rather than supply-side measures of industry *inputs* and *outputs*.

In aggregate then, the proposed infrastructure performance and customer satisfaction framework comprises nine standard measurement elements—the seven service quality attributes, as well as activity and capacity (with capacity utilisation and productivity metrics derivable from the other measures).

Infrastructure assets

The infrastructure assets within scope include the following forms of economic infrastructure:

- roads (tolled and/or public access);
- rail (freight);
- bus/rail (public transport);
- airports;
- seaports;
- telecommunications (mobile/wireless);
- telecommunications (fixed-line call);
- telecommunications (fixed-line internet);
- electricity (transmission);
- electricity (distribution);
- electricity (retail);
- gas (transmission);
- gas (distribution);
- gas (retail); and
- water.

The performance of airlines, shipping services and other infrastructure-related services can also be encompassed by the framework.

Objective and customer perception measures

For each infrastructure asset type, the nine performance measures will have an associated objective measures.[13] User ratings or user perceptions can then be collected for the seven service quality attribute measures.

Within each of the nine broad service measures, there may be more than one relevant metric for a particular piece of infrastructure or service—some infrastructure may have several elements that contribute to the overall customer experience or service performance. For example, the availability of airport infrastructure services experienced by passengers may be measured by the number of access options, such as the number of public transport connections or the number of kerbside pick-up/drop-off points, or the number of flights per day. For other infrastructure services, users may not directly experience the various constituent elements of the service and only see the total time or reliability of the services. For example, goods-handling services provided by ports and intermodal terminals.

There does not appear to be any rigorous methodological approach to identifying the most relevant or most suitable infrastructure performance measures in any particular circumstance. The measures used in the academic literature are not consistent across similar

13 There is no current, widely used measure of information provision as a service quality attribute; not all asset types may have an objective measure of information provision. At this stage, a viable alternative may be to determine if real-time information is available for an asset, and for which service quality attributes.

classes of infrastructure, nor do researchers provide much justification for why certain measures were selected. Frequently, measures appear to have been chosen based on data availability. Selection of the most appropriate objective measures will thus rely on professional judgement. Where possible, objective measures should focus on activities relevant to customers, rather than activities relevant to the infrastructure operator.

The customer

The distinction between different segments of some asset types is necessary, as each segment's customers are not the same. Many infrastructure asset types will have more than one group of customers. For example, airport customers may be divided into three mutually exclusive groups: passengers, airlines, and freight and logistics companies. There may be different objective performance measures relevant to each group for any particular service quality attribute. Additionally, different service elements may be relevant in measuring customer satisfaction across the different user groups.

For some infrastructure asset types, some customers will not be in a position to judge all attributes of infrastructure service provision. For example, households have little information or experience to be able to judge the safety of the electricity transmission network. In these cases, an infrastructure performance and customer service metric will not be calculated. This approach is consistent with Eboli and Mazzulla (2011), who argue that an individual's ability to judge service quality is predicated on their direct experience with that aspect of the service.

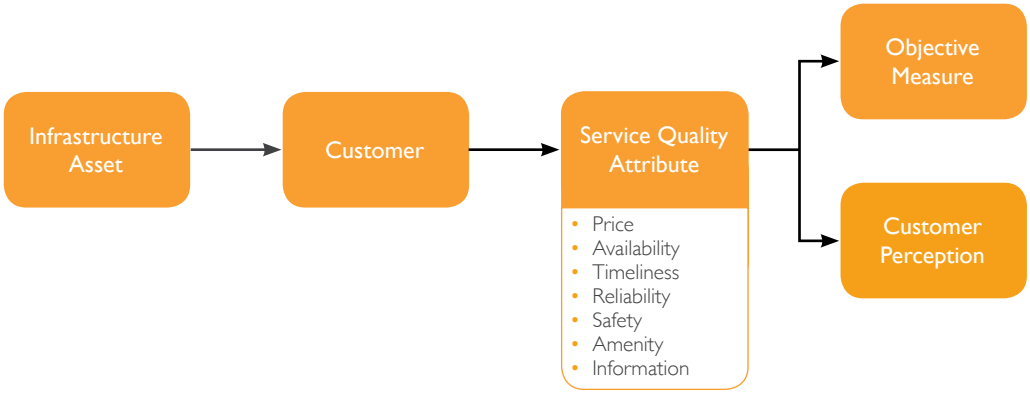
Measurement of each service quality attribute also involves a survey of customer perceptions—a subjective measure of service quality. For this reason, it is important that an objective measure be linked with an aspect of service quality that can be used in customer surveys, since the objective and subjective measures will be combined into a single metric for each service quality attribute. For example, using congestion as an objective measure of road reliability is appropriate because road users have experience of congestion. Customers are not surveyed on the supplementary measures, activity and capacity, as customers do not directly experience them, and any issues caused by them should be captured by the seven service quality attributes. An infrastructure performance and customer satisfaction metric is thus not calculated for the activity and capacity measures.

5.3 Application

Implementing the infrastructure performance and customer satisfaction framework involves the process identified in Figure 5.1. The framework involves identifying,

1. the infrastructure asset type;
2. the customer segment; and
3. an objective measure and customer perception measure for each service quality attribute, and an objective measure for each supplementary output attribute.

Figure 5.1 Infrastructure performance and customer satisfaction framework, flow diagram



Once objective measure and customer perception pairs have been identified, it is then envisaged that they be combined into a single metric for each service quality attribute using Eboli and Mazzulla's (2011) methodology, as shown in Figure 5.2. As described in Section 2.4, the metric "aims to develop an indicator which assumes an intermediate value between the subjective and objective measures of service quality, calculated by considering the [statistical] bias of the two different measures" (Eboli and Mazzulla, 2011, p. 174). It does this by defining an indicator for each attribute through generalised least squares. The sum of the standard deviations of the customer perception and objective measure are minimised and weighted in inverse proportion to the variance of the errors of the customer perception and objective measure. The result is that when the variance of the customer perception measure is close or equal to zero, the new indicator tends to coincide with customer perception of performance, rather than the objective measure of performance (Eboli and Mazzulla, 2011, p. 180).

Figure 5.2 Infrastructure performance and customer satisfaction metric, flow diagram

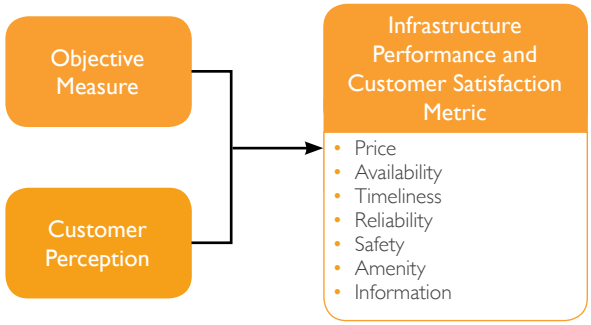
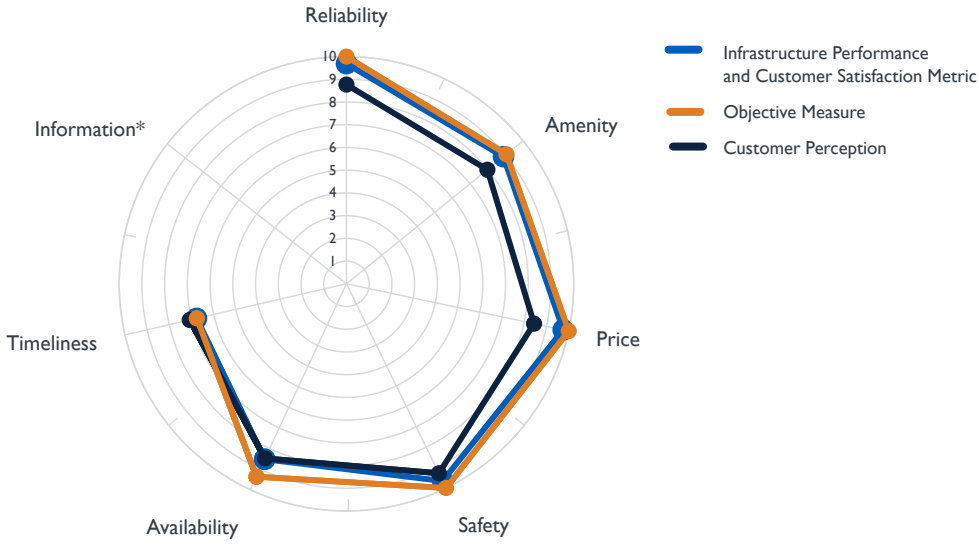


Figure 5.3 shows an example of how results from combining objective measures and customer perceptions using Eboli and Mazzulla's (2011) data and methodology can be displayed. In this example, the infrastructure performance and customer satisfaction metrics converge with the objective performance measure for most service quality attributes, indicating that customer opinion of the performance of those particular attributes are divided. The metric for availability, however, converges with customer opinion, indicating that customers are in more agreement about the availability of the service.

Figure 5.3 Infrastructure performance and customer satisfaction framework, example



* not applicable

Source: Adapted from Eboli and Mazzulla (2011).

Level of application

The framework is sufficiently general enough to accommodate measurement at levels across any particular infrastructure. For example, the framework can accommodate network-wide infrastructure performance measurement—such as the road network performance measures currently reported by some Australian state and territory road agencies—and facility-specific performance measurement—for example, an airport, port or segment of motorway. The appropriate performance measures to be used in each case will vary with the particular level of application.

The framework could equally be applied to separate customer groups—for example, air travellers, freight forwarders or airlines for airports—or segmented by different types of users within a particular customer group—for example, passenger and freight road users, or different commodity sector firms for a particular port. The level of application is reliant on the quality and scope of data collection and customer surveys.

5.4 Example applications

This section provides some example of how the framework might be applied to several sample sectors.

Airports

Tables 5.1, 5.2 and 5.3 present the infrastructure performance and customer satisfaction framework in a form that shows how it might be applied to airports. Each table identifies a

possible application of the framework to each of the three main airport customers—airlines, passengers and freight companies—and possible objective measures for each service quality attribute. Many of the measures are already captured in the ACCC's (2016) *Airport Monitoring Report,* but further consideration could be given as to which measures are the most suitable proxies for each service quality attribute.

Ideally, customer satisfaction measures would be aligned with selected objective measures, and collected via a survey of the relevant customers. Again, the ACCC *Airport Monitoring Report* already adopts this approach for many of the measures it reports. For example, the ACCC report includes objective measures of terminal kerbside services for passenger pick-up and drop-off and surveys passengers for their rating of kerbside services, congestion and waiting times.

If both objective and customer perception measures have been collected, it is then possible to combine them into an infrastructure performance and customer service metric for each service quality attribute using Eboli and Mazzulla's (2011) methodology. For example, the objective measure and surveyed customer rating of on-time performance of passenger flights are combined into a single metric of reliability for passengers.

This process is undertaken for each service quality attribute for each customer group.

Table 5.1 Application of infrastructure performance and customer satisfaction framework, airports – passengers

Service quality attribute	Candidate objective measures	Customer perception
Price	Non-aeronautical revenue/EBITA profit per passenger ($)	Passenger rating of airport costs
Availability	Number of airport access facilities designated for passenger pick-up and drop-off, including car park capacity, public transport connections	Passenger rating of airport access facilities
Timeliness	On-time performance of passenger flights	Passenger rating of on-time performance of passenger flights
Reliability	Variability in on-time performance of passenger flights	Passenger rating of on-time performance of passenger flights
Safety	Landside casualties	Passenger rating of landside safety
Amenity	Gate lounges per passenger, etc.	Passenger rating of range of shops/ cleanliness/ease of navigation/ crowding in terminal
Information[a]	Number of information boards in terminals, availability of real-time electronic flight advisory service	Passenger rating of information services at airports
Activity	Number air passengers Number airport visitors	na
Capacity	Kerbside drop-off/pick-up space Number of car parking spaces	na

a. The ACCC's performance measures include some information service quality measures as part of passenger amenity measures—e.g. number of information boards in terminals—but do not list information service quality as a separate quality attribute. The current measures do not appear to include customer perception measures of information-related attributes.

Table 5.2 Application of infrastructure performance and customer satisfaction framework, airports – air freight customers

Service quality attribute	Candidate objective measures	Customer perception
Price	Cost of freight services	Freight forwarder rating of air freight service costs
Availability	Customs clearance facilities	Freight forwarder rating of airport import freight processing facilities
Timeliness	On-time performance of air freight flights	Freight forwarder rating of on-time performance of passenger flights
Reliability	Average delay in freight processing caused by airport	Freight forwarder rating of on-time performance of passenger flights
Safety	Airside casualties/number of accidents caused by airport	Freight forwarder rating of airside safety
Amenity	na	na
Information	na	na
Activity	Total air freight Total freight aircraft movements	na
Capacity	Aircraft freight loading capacity Airport freight storage capacity	na

Table 5.3 Application of infrastructure performance and customer satisfaction framework, airports – airlines

Service quality attribute	Candidate objective measures	Customer perception
Price	Cost of aeronautical services	Airline rating of cost of aeronautical services
Availability	Capacity of runway, taxiway, apron, aircraft parking, baggage processing facilities, aerobridges, passenger related services, etc.	Airline rating of capacity of runway, taxiway, apron, aircraft parking, baggage processing facilities, aerobridges, passenger related services, etc.
Timeliness	On-time performance	Airline rating of on-time performance
Reliability	Average delay caused by airport	Airline rating of average delay caused by airport
Safety	Airside casualties/number of accidents caused by airport	Airline rating of airside safety
Amenity	na	na
Information[a]	na	na
Activity	Number or air passengers Number of airport visitors	na
Capacity	Number of aprons Number of gates Number of landing slots	na

a. The ACCC's performance measures do not include some amenity and information measures as part of its airline satisfaction measures.

Toll roads

Table 5.4 presents the framework for how it might be applied to roads. Most of the measures are taken from the TGP performance contract, so would most readily apply to toll roads, or other individual major roads, rather than a road network as a whole.

Table 5.4 Application of infrastructure performance and customer satisfaction framework, toll roads

Service quality attribute	Candidate objective measures	Customer perception
Price	Cost of toll Average annual increase in toll	Road user rating of toll price
Availability	Percentage of time during the period whole road is available to traffic	Road user rating of road availability
Timeliness	Average time to delivery of upgrades/maintenance	Road user rating of duration of road works
Reliability	Percentage of time during the period where travel times exceed baseline travel time	Road user rating of travel time reliability/congestion
Safety	Number of incidents not responded to within 25 minutes after receipt of notification Number of causalities/road crashes/fatalities on road	Road user rating of safety of road Road user rating of incident response
Amenity	Percentage of road meeting pavement condition assessment standard	Road user rating of road surface
Information	Availability of real-time road and travel condition information to road users	Road user rating of information services (e.g. road closure, travel time advice, etc.)
Activity	Average daily traffic	na
Capacity	Maximum free flow traffic capacity	na

5.5 Benefits and limitations of a standard framework

Benefits

The proposed infrastructure performance and customer service framework benefits from flexibility, ease of implementation, and clarity of interpretation.

The first benefit is that it can be used across different infrastructure asset types. By dividing service quality into standard attributes applicable across various asset types, some degree of comparison can be made between the performance of different assets.

Implementing the infrastructure performance and customer service framework is also relatively simple for infrastructure operators. Some objective performance indicators already exist, and customer surveys are already used by many infrastructure operators. The framework avoids the need for costly focus-groups or other labour-intensive methods to collect information on consumer preferences.

Interpreting the framework is easier than with other models. First, infrastructure operators benefit from being able to individually observe the objective and subjective indicators separately before they are combined. Once combined, the results make it clear which indicator most influenced the final infrastructure performance and customer service metric.

Limitations

Further work is required to fully flesh out the framework. In particular, specific objective performance measures are yet to be identified across the various infrastructure sectors, and it needs to be determined if the objective performance indicators are actually measuring the service quality attributes they're intended to measure.

The framework also relies on infrastructure operators collecting relevant performance data on their assets, as well as undertaking customer satisfaction surveys. For many infrastructure operators the resources involved in collecting and reporting performance measures may be significant. In addition, no Australian infrastructure provider, apart from the airports covered by the *Airport Monitoring Report,* currently undertakes the comprehensive customer satisfaction surveys envisaged under the framework.

The framework also does not address some of the questions raised in Chapter 2. Specifically, it does not weight each attribute by their importance to customers, nor does it provide a solution for recency bias in customer surveys. The literature is yet to identify proven, reliable methods for correcting these two issues, and it was beyond the scope of this project to resolve them. The framework thus does not resolve the order in which to prioritise service quality improvement where multiple attributes report low customer satisfaction. This problem appears broadly similar to issues surrounding willingness-to-pay in environmental and agricultural economics. The latter literature may provide useful areas for future research. Customer recency bias appears to be a more intractable issue, and may be significant over the lifetime of an asset if satisfaction survey results remain steady even as objective measures of performance improve.

A further unresolved issue is how to measure asset types that are not homogenous in service. For example, airports are discrete assets; two customers at the same airport may expect to have similar experiences on two different days. This is not the case for public transport or roads, where service quality varies across regions and/or across the time of day. In addition, using a single infrastructure performance and customer service metric for a state or territory's entire road network would hide significant and important variations in service quality, reducing the usefulness of the measure for road agencies. In this case, road agencies may want to apply the framework to smaller segments of their networks.

A final issue is that the infrastructure performance and customer service framework does not account for service quality attributes that may not be suitable for rating on a scale. For example, as discussed in Chapter 2, it is possible that households lack information to rate, for example, the reliability of the gas network in anything but a "good/bad" rating, as their only experience of reliability is on the rare occasions when gas is unavailable. Other gas market participants may have better information, and would thus be better placed to rate reliability on a point scale.

5.6 Concluding remarks

The infrastructure performance and customer satisfaction framework is a flexible framework into which existing and future performance measures can be adapted. Rather than replacing existing data collection efforts, it provides a useful way to present information on infrastructure performance to customers and to the public, and one that allows for high-level comparisons

between assets. Public agencies responsible for regulating, constructing or maintaining infrastructure, as well as private infrastructure operators, are best placed to identify specific measures for each service quality attribute. Many may already collect some relevant data. The framework may also be a useful guide for agencies or infrastructure operators planning to begin collecting performance data on the assets they control, by prompting them to consider which performance measures are most important to their customers.

APPENDIX A

Review of customer satisfaction methods

This appendix provides a brief overview of some of the methods that have been used in the literature to measure customer satisfaction.

Table A.1 Review of customer satisfaction methods

Model	Advantages	Disadvantages
SERVQUAL	Most basic model; allows creation of an overall index	Uses many concepts (may be confusing and increase surveys' length); all attributes are equally important; does not account for heterogeneity; changes in individual components may be masked
Weighted SERVQUAL	Different weights for each attribute; allows creation of an overall index	Uses many concepts (may be confusing and increase surveys' length); does not account for heterogeneity; changes in individual components may be masked
Fuzzy weighted SERVQUAL	Different weights for each attribute; handles subjective information; allows creation of an overall index	Uses many concepts (may be confusing and increase surveys' length); does not account for heterogeneity; changes in individual components may be masked; calculation is complex
Customer Satisfaction Index (CSI)	Different weights for each attribute; allows creation of an overall index	Does not account for heterogeneity; changes in individual components may be masked
Heterogeneity Customer Satisfaction Index (HSCSI)	Different weights for each attribute; allows creation of an overall index	Changes in individual components may be masked
Multicriteria Analysis (MA) (Satisfaction)	Allows creation of an overall index	Does not account for heterogeneity; changes in individual components may be masked
MA – TOPSIS	Allows creation of an overall index	All attributes are equally important; does not account for heterogeneity
MA – Fuzzy TOPSIS	Handles subjective information; allows creation of an overall index	All attributes are equally important; does not account for heterogeneity
MA – VIKOR	Different weights for each attribute; allows creation of an overall index	Does not account for heterogeneity
SERVPERF	Most basic model; allows creation of an overall index	All attributes are equally important; does not account for heterogeneity; changes in individual components may be masked
Weight SERVPERF	Different weights for each attribute; allows creation of an overall index	Does not account for heterogeneity; changes in individual components may be masked; calculation is complex

continued...

Model	Advantages	Disadvantages
Fuzzy weighted SERVPERF	Different weight for each attribute; handles subjective information; allows creation of an overall index	Does not account for heterogeneity; changes in individual components may be masked; calculation is complex
Importance-Performance Analysis	Most basic model; easily-interpreted (graphical tool); different weights for each attribute; allows for setting priorities for improvement	Visualising method with no precise ranking of priority; does not account for heterogeneity; passengers tend to rate all attributes as important
Eboli and Mazzulla, 2011	Sets priorities for improvements; accounts for heterogeneity; jointly uses subjective and objective data	All attributes equally important
Zone of Tolerance (ZOT) expectations	Sets priorities for improvement	Uses many concepts (may be confusing and increase surveys' length); all attributes are equally important; does not account for heterogeneity
Fuzzy ZOT	Sets priorities for improvement; handles subjective information	Uses many concepts (may be confusing and increase surveys' length); all attributes are equally important; does not account for heterogeneity; calculation is complex
Normalised Importance ZOT of expectations for evaluating Service Quality (NIZSQ)	Different weights for each attribute; sets a precise ranking of the priority of improvements based on the ZOT and normalised importance	Uses many concepts (may be confusing and increase surveys' length); does not account for heterogeneity; complex process

Source: de Oña and de Oña (2014).

APPENDIX B

Infrastructure performance measurement frameworks

This appendix presents the infrastructure performance measurement frameworks referred to in Chapter 3.

Note that not all case studies have associated tables.

Austroads National Performance Indicators

Note: Metrics on Smooth Travel Exposure distinguishing between urban and rural areas have not been included in the Table B.1 for brevity.

Table B.1 Austroads National Performance Indicators

Area	Core indicators	Indicator	Description	Goal
Road safety		Serious casualty crashes (population)	The number of serious casualty crashes per year normalised per 100,000 head of population.	Minimise
		Serious casualty crashes (vehicle-kilometres travelled)	The number of serious casualty crashes normalised per 100 million kilometres of travel.	Minimise
	Core indicator	Road fatalities (population)	The crash experience expressed in terms of fatalities per year, normalised per 100,000 head of population.	Minimise
		Road fatalities (vehicle-kilometres travelled) indicator	The crash experience expressed in terms of fatalities per year, normalised per 100 million kilometres of travel	Minimise
		Persons hospitalised (population) indicator	The crash experience expressed in terms of persons hospitalised per year, normalised for population.	Minimise
		Persons hospitalised (vehicle-km travelled)	The crash experience expressed in terms of persons hospitalised per year, normalised per 100 million vehicle kilometres of travel	Minimise
		Social cost of serious casualty crashes (population)	$ million cost of serious casualty crashes per 100,000 population	Minimise
		Social cost of serious casualty crashes (vehicle-kilometres travelled)	$ million cost of serious casualty crashes per 100 million kilometres of travel	Minimise

continued...

Area	Core indicators	Indicator	Description	Goal
Asset management	Core indicator	Smooth travel exposure (all 4.2 IRI)	Proportion of travel undertaken each year on all roads with a roughness level condition of less than 4.2 IRI	Maximise
	Core indicator	Smooth travel exposure for National Land Transport Network (all 4.2 IRI)	Proportion of travel undertaken each year on the National Land Transport Network with a roughness level condition of less than 4.2 IRI	Maximise
	Core indicator	Smooth travel exposure (all 5.33 IRI)	Proportion of travel undertaken each year on all roads with a roughness level condition of less than 5.33 IRI	Maximise
	Core indicator	Smooth travel exposure for National Land Transport Network (all 5.33 IRI)	Proportion of travel undertaken each year on the National Land Transport Network with a roughness level condition of less than 5.33 IRI	Maximise
Program/ project assessment	Core indicator	Return on construction expenditure by state	Percentage distribution of programmed expenditures by benefit cost ratio (BCR) range	>unity, normally distributed, small variance
Travel speed	Core indicator	Actual travel speed (urban)	Weighted aggregate speed on a representative sample of arterial roads and freeways in major cities calculated for am/pm peak, off-peak, and whole day	Maximise (subject to constraints, eg. Safety)
		Nominal travel speed (urban)	Weighted aggregate speed on a representative sample of arterial roads and freeways in major cities (assuming vehicles travel at the posted speed limit)	Evaluate network
		Congestion indicator (urban) (min/km)	Difference between actual and nominal travel time — delay from traffic conditions which do not permit travel at the posted speed limit, calculated for am/pm peak, off-peak, and whole day	Evaluate network capability
		Variability of travel time (urban)	Variability of travel time on a representative sample of arterial roads and freeways in the urban metropolitan area, calculated for am/pm peak, off-peak, and whole day	Minimise
Lane occupancy rate	Core indicator	Lane occupancy rate (persons)	The average number of persons per lane per hour during a specified period on a representative sample of arterial roads and freeways in the urban metropolitan area, calculated for am/pm peak, off-peak, and whole day	Maximise
		Car occupancy rate	The average number of persons per car during a specified period on a representative sample of arterial roads and freeways in the urban metropolitan area, calculated for am/pm peak, off-peak, and whole day	Maximise

continued...

Area	Core indicators	Indicator	Description	Goal
Congestion		Average travel time per 10 km performance indicator	The average travel time per 10 km during a specified time on a representative sample of freeways and motorways, calculated for am/pm peak, and 1pm-3pm	Minimise the average travel time per 10 km (subject to constraints, e.g. Safety)
		Average travel time per 10 km performance indicator (based on floating car survey data)	Average travel time per 10 km journey obtained from travel time data acquired through floating car surveys during a specified time on a representative sample of arterial roads, calculated for am/pm peak, and 1pm-3pm	Minimise the average travel time per 10 km (subject to constraints, e.g. Safety)
		Variation from posted speed	Differential between the posted speeds and the calculated speeds measured by a traffic control system during a specified time on a representative sample of freeways and motorways, calculated for am/pm peak, and 1pm-3pm	Minimise the time and proportion of a network with speeds significantly lower than the posted speed limits
		Variation from posted speed performance indicator (based on floating car survey data)	Differential between the posted speeds and the calculated speeds as measured through floating car surveys during a specified time on a representative sample of arterial roads, calculated for am/pm peak, and 1pm-3pm	Minimise the time and proportion of a network with speeds significantly lower than the posted speed limits
		Reliability (variability of travel time for a typical trip)	Proportion of a road network at various levels of reliability based on the variability of travel time during a specified time on a representative sample of freeways and motorways, calculated for am/pm peak, and 1pm-3pm	Reduce the variability of travel time on a road network
		Reliability (variability of travel time for a typical trip) performance indicator (based on floating car survey data)	Proportion of a road network at various levels of reliability based on the variability of travel time during a specified time on a representative sample of arterial roads, calculated for am/pm peak, and 1pm-3pm	Reduce the variability of travel time on a road network
		Speed and flow	Productivity of a network measured in terms of the product of speed and flow by benchmarking against reference values of speed and flow during a specified time on a representative sample of freeways and motorways, calculated for am/pm peak, and 1pm-3pm	Minimise the loss of productivity of a network due to flow breakdowns in real-time operation and in the planning context
		Speed and flow performance indicator (based on floating car survey data)	Productivity of a network measured in terms of the product of speed and flow by benchmarking against reference values of speed and flow during a specified time on a representative sample of arterial roads, calculated for am/pm peak, and 1pm-3pm	Minimise the loss of productivity of a network due to flow breakdowns in real-time operation and in the planning context
User satisfaction	Core indicator	User satisfaction index	Index of users' qualitative evaluation of satisfaction with road system outcomes expressed as a mean score out of 5	Increase

Source: Austroads (2017).

Austroads Levels of Service Framework for Non-Freight Users

Table B.2 Austroads Levels of Service Framework for Non-Freight Users

LOS needs	LOS narratives for non-freight customers	Example technical performance measures	Service metrics	User importance rating	Acceptability function	Examples of possible target service values
Road and RRA conditions	Ride comfort/ quality, surface conditions and geometrics as needed	Potholes not frequent enough to be annoying or affect driving	No. of potholes per lane per km	Not assessed	Difficult to establish acceptability function	< 1
		Road smooth enough for occupant comfort	Mean International Roughness Index (IPI) (m/km)	Very important	Several studies available; could do with updating	1.6 m/km
		Road wide enough for comfortable driving	% of road pavement with inadequate seal width	Very important	No function currently available; could readily be determined using a driving simulator	< 20%
		Curves, grades and their combination support comfortable driving at an acceptable speed	% of road pavement with inadequate road geometric designs; % with low advisory speeds could be an easy way to capture this	Not assessed	Needs more detailed definition; relationship between acceptability and advisory speed could be determined by simulator experiment; this could be related to advisory speeds determined by road geometry surveys	< 20%
	Road pavement and bridges in good condition	Road pavement and bridges have sufficient strength for expected traffic	% of pavement and bridge lengths (km) fit for purpose	Not assessed	Not possible to translate into acceptability function – some form of engineering judgement required	< 20%
	Adequate drainage structures/ systems including culverts	Road free from ponding and water film sufficient to create risk of aquaplaning	% of drains blocked	Not assessed	Not feasible to translate into acceptability function – some form of collective engineering judgement required. Alternatively, could make the technical performance measure the number of occasions/year when there is a problem with water on the road, either in the form of ponding or potential aquaplaning	< 20%

continued...

LOS needs	LOS narratives for non-freight customers	Example technical performance measures	Service metrics	User importance rating	Acceptability function	Examples of possible target service values
Road and RRA conditions	Road corridors clean, well maintained, aesthetically pleasing	Road corridors should be clean, well maintained, aesthetically pleasing	% of corridors insufficiently clean, well maintained, aesthetically pleasing; could possibly develop measure of visible litter items/km	Moderately important	Cleanliness and maintenance acceptability function could be established using photographic material; perhaps a computer display where elements are added or subtracted would be a suitable way to investigate this issue	< 20%
	Sufficient sealed shoulder width for cyclists	Sufficient shoulder width to provide adequate lateral separation from motor traffic	% of cycle paths with inadequate sealed shoulder	Not assessed	Acceptability function possible either using a group of cyclists to ride on different facilities and make ratings, or (less satisfactorily) use group of cyclists with photographic materials	< 20%
	Sufficient smoothness for safe travel on bike lanes and bike paths	Vertical displacements close to the bicycle seat	Accelerometer output (root mean square displacement); IRI	Not assessed	Acceptability function available for flexible and rigid (concrete slab) bicycle paths	1.6 m/km (asphalt); < 5 displace ments (8 mm or greater) per 100 m (concrete)
Safety	Adoption of a Safe System approach to support safe travel	Safe road conditions as measured by ANRAM or AusRAP assessment	% of roads with 1 or 2 stars	Safety was rated as the most important aspect of travel – no ratings specific to this safety item	Difficult to see how this can be related to user opinions in any direct way (elaborate trade-off type experiment may be possible but perhaps not very credible) – suggest some form of collective engineering judgement is used	< 20%
		Low crash risk for road users	% of roads with the total number of crashes per veh-km travelled (VKT) deemed as high	Safety was rated as the most important aspect of travel – no ratings specific to this safety item	As above	< 20%
	Safe footpaths for pedestrians	Footpath free of tripping hazards	No. of tripping points per 100 m of footpath	Not assessed	Acceptability function possible using a group of pedestrians to walk different facilities and make ratings; otherwise some form of collective engineering judgement	< 1
	Safe overtaking opportunities on rural roads	Adequate overtaking opportunities on two-lane roads	% of two-lane roads with more than 5 km between overtaking opportunities under normal maximum traffic	Moderately important	May be possible to establish through a simulator experiment	< 20%

continued...

LOS needs	LOS narratives for non-freight customers	Example technical performance measures	Service metrics	User importance rating	Acceptability function	Examples of possible target service values
Safety	Fatigue prevention with adequate rest areas and stopping places	Availability of rest areas	% of road corridors with more than two hours between adequate rest areas	Less important	Not feasible to investigate – would require very long sessions in the simulator, but without being able to realistically simulate rest stops – would lack credibility. Best approach is probably to use professional judgement, based on fatigue literature and past surveys	< 20%
	Adequate street lighting	Adequate lighting in places where lighting is required	% of road network where lighting is required but is not adequate; % road network conforming to current lighting standards	Not measured	Could develop acceptability function through field trial; might be possible to approximate this using video, but restricted range of brightness on video compared to real life would limit veracity. Current lighting standards could perhaps be used as acceptable surrogate.	-
		Reliable lighting provided at all times when required	% of light units failing in a specified time (e.g. per year); alternatively number of location days where lighting was inadequate	Not measured	Difficult to relate to user acceptability directly; recommend an approach based on professional judgement	> 3%
	Sufficient sealed shoulder width for cyclists	Sufficient shoulder width to provide adequate lateral separation from motor traffic	% of on-road cycle facilities with inadequate sealed shoulder	Not assessed	Acceptability function possible either using a group of cyclists to ride on different facilities and make ratings, or (less satisfactorily) use group of cyclists with photographic materials	< 20%
Mobility and access	Efficient travel and consistent travel times on rural roads	Sufficient road capacity to support comfortable travel and free flowing traffic at all times	% of road routes showing excessive recurrent delay	Not assessed	Adapt material from the Highway Capacity Manual	< 20%
		Adequate overtaking opportunities on two-lane roads	% of two-lane roads with more than 5 km between overtaking opportunities under normal maximum traffic	Moderately important	May be possible to establish through a simulator experiment	< 20%
		All-weather availability	Number of incidents per year due to flooding, landslides or other weather-related events; alternatively number of days when road is not available due to flooding, etc	Not assessed	Use professional judgement to develop function, informed by community consultation and an estimate of the costs and other consequences arising from non-availability	< 2 incidents or 4 days per year

continued...

LOS needs	LOS narratives for non-freight customers	Example technical performance measures	Service metrics	User importance rating	Acceptability function	Examples of possible target service values
		Adequate road configuration and geometry	% of rural roads with inadequate shoulder width, seal width, horizontal and vertical alignment and high gradient; and low advisory speeds as established by GPS-based road survey	Not assessed	Possibility of simulator study to establish critical values based on advisory speeds	< 20%
	Efficient travel and consistent journey times on urban roads	Acceptable journey times; absence of queues	% of days (or hours?) per year with unacceptable Austroads NPIs on travel efficiency	Not assessed	Community consultation or professional judgement to arrive at acceptability function values	< 20%
		Reliable travel times for cars and buses (and freight vehicles)	% of days (or % of hours?) per year with excessive high Austroads NPI on variability of travel time	Not assessed	Community survey asking about time taken for usual trip and point at which delay becomes unacceptable	< 20%
		Delay due to inadequate management of planned events (e.g. roadworks, VIP visits, etc.) and unplanned events (e.g. road crashes, flooding, etc.)	% of the days per year with reported excessive delay due to planned and unplanned events per day	Not assessed	Community consultation or professional judgement to arrive at Acceptability Function values	< 20%
	Adequate transport options	Availability of viable multiple transport modes	% of trips that can use public transport, walking and cycling	Not assessed	Use professional judgement to develop acceptability matrix	> 50%

Source: Austroads (2016).

Austroads Heavy Vehicle Infrastructure Rating

Table B.3 Austroads Heavy Vehicle Infrastructure Rating, expected values for access

Road category	Mass limit (tonnes)		Length limit (m)		Expected score	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
R1	50	50	53.5	19	0.57	0.38
R2	50	50	26	19	0.44	0.38
R3	50	50	26	19	0.44	0.38
R4	50	50	26	19	0.44	0.38
R5	50	50	19	19	0.38	0.38

Source: Austroads (2015).

Table B.4 Austroads Heavy Vehicle Infrastructure Rating, expected values for ride quality

Road category	IRI (m/km)		Expected score	
	Maximum	Minimum	Maximum	Minimum
R1	2.0	4	1.00	0.75
R2	2.5	5	0.94	0.63
R3	3.0	6	0.88	0.50
R4	3.5	8	0.81	0.25
R5	4.0	10	0.75	0.00

Source: Austroads (2015).

Table B.5 Austroads Heavy Vehicle Infrastructure Rating, expected values for safety

Road category	Lane width (m)		Sealed shoulder width (m)		Expected score	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
R1	3.3	2.9	3.0	205.0	1.00	0.42
R2	3.3	2.9	2.5	0.5	0.92	0.08
R3	3.3	2.9	2.0	0.5	0.83	0.08
R4	3.3	2.9	1.5	0.0	0.75	0.00
R5	3.3	2.9	1.0	0.0	0.67	0.00

Source: Austroads (2015).

Western Australia: Main Roads Western Australia Key Performance Measures

Note: Three indicators, one measuring the performance of traffic signalling and other equipment, and one on the effectiveness of road safety campaigns, and another on the percentage of Office of Road Safety projects completed on budget and on time, have been removed from the list of reported indicators since the handbook's publication. Several indicators have been added under the new outcome, "Improving Community Access and Roadside Amenity," since the handbook's publication.

Table B.6 Main Roads Western Australia Key Performance Measures

	Measure	Target	Reporting cycle
A safer road environment			
Community Satisfaction of Road Safety	The percentage of Community Perceptions Survey respondents responding that they are satisfied with the safety of the state road network	90%	Yearly
Blackspot location index	The number of the Black Spot Qualifying Locations on the State Road Network per 100 million vehicle tonne kilometres for the entire state road network	Target is established based on the anticipated outcome based on the proposed future work program. Target for 2016 was 9.4	Yearly
Reliable and efficient movement of people and goods			
Community Satisfaction	The percentage of Community Perceptions Survey respondents responding that they are satisfied with MRWA's overall performance in the construction, maintenance and management of the state road network	90%	Yearly
Road Network Permitted for use by Heavy Freight Vehicles	The percentage of available state and national roads accessible by Class 10, Class 11 and Class 12 vehicles	This target is based on fact and takes into account anticipated increases in the network based on changes to government policy or expansions to the network. Target for 2016 varied depending on vehicle class, ranging from 44% for triple road trains, to 96% for B doubles	Yearly
Network Configuration – Roads	The percentage of travel undertaken on roads meeting specific criteria for seal width, carriageway width and curve rating	Target based on anticipated results taking into account known works programs and the likely impact on the measure. Target for 2016 was 90%	Yearly
Network Configuration – Bridges	The percentage of bridges on main roads and highways that satisfy bridge width and strength standards.	Target based on anticipated results taking into account known works programs and the likely impact on the measure. Strength target for 2016 was 89%; width target was 95%	Yearly

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	Measure	Target	Reporting cycle
Improved community access and roadside amenity			
Unplanned road closure on the state road network	The percentage of the year that the state road network was 100% available to road users, i.e. When there are no road closures anywhere on the state road network	Target based on previous year's trends given it seeks to anticipate the annual impact of weather events and bushfires on the network. Target for 2016 was 85%	Yearly with status updates provided each quarter
Community Satisfaction with Cycleways and Pedestrian Facilities	The percentage of Community Perceptions Survey respondents responding that they are satisfied with MRWA's overall performance in the construction, maintenance and management of cycleways and pedestrian facilities on the metropolitan (Perth) road network	90%	Yearly
A well maintained road network			
Smooth Travel Exposure	The percentage of travel on the sealed road network that occurs on roads, which are within the roughness limits defined by the Asset Management Planning Investigatory Criteria	Target based on anticipated results taking into account known works programs and the likely impact on the measure. Measure is biennial. Target in 2015 was 97%	Yearly
Community Satisfaction of Road Maintenance	The percentage of Community Perceptions Survey respondents responding that they are satisfied with MRWA's overall performance in the maintenance of the state road network	90%	Yearly
Preventative Maintenance Indicator	The indicator compares the surface age of the road against the target maximum surfacing age (optimum target age) for the section of road and reports on the percentage of the sealed network falling into the category of 'Good'	Target based on anticipated results taking into account known works programs and the likely impact on the measure. Target for 2016 was 84%	Yearly
Average Cost of road network maintenance per lane kilometre	Indicator identifies the average cost of maintaining a lane kilometre of the State Freeway, Highway and Main Road network	A target is established based on the anticipated expenditure against the length of road network. Target for 2016 was $7,700	Yearly
Average Cost of network management per million vehicle kilometres	The indicator represents the financial efficiency of the Road System's Management by showing the cost per million vehicle-kilometres travelled (MVKT) to manage the operations of the State road network (includes some operations on local roads such as traffic signals, which MRWA has responsibility for). The KPI includes some Finance and Other Costs spread over the Program	A target is established based on the anticipated expenditure against an estimate of MVKT. Target for 2016 was $5,349	Yearly
Facilitate economic and regional development			
Return on construction expenditure	The Return on Construction Expenditure (RCE) KPI summarises the expenditure in the Road Infrastructure for State Development Program. The expenditure is summarised by the Benefit Cost Ratios (BCRs) of the projects upon which the expenditure was allocated	Target based on anticipated results taking into account known works programs and the likely impact on the measure. Target for 2016 was 4.3	Yearly

continued...

	Measure	Target	Reporting cycle
Percentage of contracts completed on time and budget	The indicator identifies the percentage of works projects within each Program that achieve on time on cost delivery	The target was based on research to determine what other jurisdictional road agencies were reporting on at the time of the 2007 review. At that time Qld, Vic and NSW all used a 90% target	Yearly
Improving community access and roadside amenity (new)			
Percentage of the year that 100 per cent of the Main Roads' State road network is available	The availability of the sealed road network is measured as a percentage of calendar days that the whole network is available to the road user. Closure is determined by measuring the number of whole days (24 hours commencing from the time the road is closed) that any section of the sealed road network is closed	85%	Yearly
Community satisfaction with cycleways and pedestrian facilities	This indicator represents how satisfied the community is with Main Roads' performance in the construction, maintenance and management of cycleways and pedestrian facilities	90%	Yearly
Percentage of contracts completed on time	This indicator represents the percentage of contracts that were delivered on time in the Community Access Program	90%	Yearly
Percentage of contracts completed on budget	This indicator represents the percentage of contracts delivered on budget in the Community Access Program	90%	Yearly

Source: Main Roads Western Australia (2012, 2016b).

Victoria: VicRoads Benefit Management Framework, Version 2

Note: while many indicators are repeated, associated measures differ between outcomes.

Table B.7 VicRoads Benefit Management Framework, Version 2

Benefit	Indicator	Measures
Road safety		
Actual safety	Frequency of casualty crashes	Number of casualty crashes by location (intersection or road length)
		Number of casualty crashes by type (intersection, run of road, rollover)
		Number of casualty crashes by user (pedestrian, heavy vehicle, public transport)
		Number of casualty crashes per 100 million vehicle kilometres travelled
	Severity of casualty crashes	Number of fatality crashes and serious injury crashes by location (intersection or road length)
		Number of fatality crashes and serious injury crashes by type (intersection, run-off road, rollover)
		Number of fatality crashes and serious injury crashes by user (pedestrian, heavy vehicle, public transport)
Perception of safety	People feel safer	% of people who feel safer
		% pedestrians using the crossing facility of the total crossing within 20m of the facility
		Safety complaints received
	Local trips made by walking and cycling	% local trips made by walking and cycling
		Number of road crossings within 20m of crossing facility
Safety risk	Severity of crash rating	Risk using exposure, crash reduction factors, ANRAM or 'Safe System' compliance.
		Frequency of conflict points
	Casualty crash rating	Risk using exposure, crash reduction factors, ANRAM or 'Safe System' compliance
		Frequency of conflict points
	Frequency of people taking risks	Number of people taking risks (visual count)
	Incident/hazard response times	Average response time in minutes
		% incidents attended or cleared within 15 mins
		% hazards managed within Road Management Plan response times
	Patronage of rest areas	Number of spaces at rest areas utilised by Heavy Vehicles during specified times
Public safety	Risk of harm (non-crash)	Level of water pollution (oil, heavy metals and other chemicals)
		Number of complaints regarding water pollution
	Fire risk	Fire risk rating (fuel load)
	Occupational health and safety risk	Level of risk assed using Safe Work Methods Statements (SWMS)

continued...

Benefit	Indicator	Measures
Community health and wellbeing		
Local amenity and environmental quality	Exposure to high noise levels	Number of dwellings experiencing noise levels above 55dB, 60dB, 65dB and 70dB
		Number of complaints received by VicRoads
	Air quality	Vehicle emissions by gas type
		Level of toxins (e.g. Benzene, toluene or formaldehyde)
		Number of complaints regarding air quality
		Number of dwellings with predicted concentrations of nitrogen dioxide above 263ug/m3 (1 hour) and/or PM10 above 60ug/m3 (24 hour) – using VicRoads Air Quality Screening Tool
	Trucks using appropriate freight routes	% of trucks using appropriate freight routes
		Number of trucks using appropriate freight routes
	Satisfaction with local amenity	% of community members satisfied with local amenity
		Number of complaints
	Local trips made by walking and cycling	Number of road crossings within 20m of crossing facility
		% of local trips made by walking and cycling
	Pedestrian movement	Pedestrians per hour during a specified time period
	Cycling activity	Cyclists per hour during a specified time period
		Number of people cycling
	Risk to Heritage Loss	Number of sites under threat
Active and inclusive communities	Equity of access	Number of DDA-compliant sites
		New trips made by individuals at risk of social exclusion
		Portion of household budgets devoted to transport
	Local trips made by walking and cycling	% of local trips made by walking and cycling
		Number of road crossings within 20m of crossing facility
	Cycling activity	Cyclists per hour during a specified time period
		Number of people cycling
	Pedestrian movement	Pedestrians per hour during a specified time period
	Travel time	Average travel time in minutes from origin to destination
	Connectivity between different modes of transport	Average variability in minutes of road based public transport travel
		Distance between collection and drop off facilities
		Pedestrian travel time between modes
		Proportion of services that are 'on time' or service punctuality
	Range of modes	Number of transport options available to a passenger within a specified distance of their home or work
	Delay	Minutes of delay (per kilometre travelled or total)
		Number of signal cycles taken to clear intersection
	Delays in accessing services and employment	% of community members satisfied with access to services and employment
	Resilience in extreme events	% or number of road closures during extreme events
		Time to return original functionality

continued...

Benefit	Indicator	Measures
Active and inclusive communities	Access (to services and employment)	% of population within a given number of minutes of services and employment
		Number of people able to reach a certain destination in a certain time
		Average time to access services and employment from different locations
		ARRB accessibility metrics (by number of opportunities accessible within a certain time by different modes)
	Public transport punctuality	% of trams or buses considered as 'on-time'
	Mode share	% of mode share
Community satisfaction	Acceptance of planned extensions to the transport network	% of community members who accept planned expansions of the transport network
	Acceptance of the impacts of existing transport on amenity	% of community members who accept of the impacts of existing transport on amenity
	Satisfaction with local amenity	% of community members satisfied with local amenity
		Number of complaints
	Satisfaction with service provided	% of community members satisfied with VicRoads' operations
		Number of complaints
	Damage to vehicle/ properties	Claims for damage to vehicles/properties
	Travel time	Average travel time in minutes from origin to destination
	Delay	Minutes of delay (per kilometre travelled or total)
		Number of signal cycles taken to clear intersection
	Delays in accessing services and employment	% of community members satisfied with access to services and employment
	Risk to Heritage Loss	Number of sites under threat
	Time saved (non-travel)	Time in minutes by community members
		Number of transactions by community members
	Travel time reliability	Average variability in minutes from origin to destination
	Vehicle operating cost	$ (including fuel, lubricating oils, tyres, vehicle depreciation, repairs and maintenance)
	Ride quality and comfort	International Roughness Index (IRI)
		Heavy Articulated Truck Index (HATI)
Productivity and Economic Growth		
Employment opportunities	Jobs created within a specified area	Square kilometres of retail and commercial floor space
	Access (to services and employment)	% of population within a given number of minutes of services and employment
		Average time to access services and employment from different locations
		ARRB accessibility metrics (by number of opportunities accessible within a certain time by different modes)
	Travel time reliability	Average variability in minutes from origin to destination
	Travel time	Travel time in minutes from a specific origin to destination during a specified time period

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Benefit	Indicator	Measures
Employment opportunities	Delays	Minutes of delay (per kilometre travelled or total)
		Number of signal cycles taken to clear intersection
	Connectivity between different modes of transport	Average variability in minutes of road based public transport travel
		Pedestrian travel time between modes
		Distance between collection and drop off facilities
		Proportion of services that are 'on time' or service punctuality
	Range of modes	Number of transport options available to a passenger within a specified distance of their home or work
	Activity centre employment catchments	Distance travelled to access an activity centre within a specified number of minutes
	Person rate of throughput	Persons per hour
	Vehicle rate of throughput	Vehicles per hour
Business and industry attractiveness	Satisfaction with service provided	% of business / industry members satisfied with VicRoads' operations
		Number of complaints
	Efficiency of goods movement	$ per tonne per km or average tonnes per km
		Tonnage per trucks / number of trucks per total tonnage movement
	Travel time	Travel time in minutes from a specific origin to destination during a specified time period
	Travel time reliability	Average variability in minutes from origin to destination
	Vehicle operating cost	$ (including fuel, lubricating oils, tyres, vehicle depreciation, repairs and maintenance)
	Ride quality and comfort	International Roughness Index (IRI)
		Heavy Articulated Truck Index (HATI)
	Damage to vehicles/ properties	Claims for damage to vehicles
	Patronage of rest areas	Number of spaces at rest areas utilised by heavy vehicles during specified times
	Time saved (non-travel)	Time in minutes by business/industry
		Number of transactions required by business/industry
	Vehicle rate of throughput	Vehicles per hour
	Freight rate of throughput	Number of trucks per hour on a section of a road during a specified time period
		Tonnes per hour
	Business activation	Number of Expressions of Interest for new businesses within a specified area
		The value of investment within a specified area
	Access to stakeholder asset	Time taken to access asset
	Activity centre employment catchments	Distance travelled to access an activity centre within a specified number of minutes
	Level of service	Level of service rating (A to F)

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Benefit	Indicator	Measures
Transport network efficiency	Delays	Minutes of delay (per kilometre travelled or total)
		Number of signal cycles taken to clear intersection
	Person rate of throughput	Persons per hour
	Travel time	Travel time in minutes from a specific origin to destination during a specified time period
	Travel time reliability	Average variability in minutes from origin to destination
	Public transport punctuality	% of trams or buses considered 'on-time'
	Cycling activity	Cyclists per hour during a specified time period
	Volume to capacity ratio	Number of persons per hour on a section of the road and maximum number of persons per hour capable of being carried in motor vehicles along the section of the road
		Number of vehicles per hour that travel along a section of the road and maximum number of vehicles per hour capable of travelling along the section of the road
	Vehicle rate of throughput	Vehicles per hour
	Connectivity between different modes of transport	Average variability in minutes of road based public transport travel
		Pedestrian travel time between modes
		Distance between collection and drop off facilities
		Proportion of services that are 'on time' or service punctuality
	Optimisation of the tram and bus fleet	Number of additional tram and bus services run on specified routes
	Optimisation of network capacity	Number of trains per hour
	Incident/hazard response times	Average response time in minutes
		% of incidents attended or cleared within 15mins
		% of hazards managed within Road Management Plan response times
	Freight rate of throughput	Number of trucks per hour on a section of a road during a specified time period
		Tonnes per hour
	Public transport patronage	Number of patrons during a specified time period on tram/bus or both on specified routes or corridors
	Level of service	Level of service rating (A to F)
Better value for money		
Reduced exposure to costs	Whole of life cost	Cost in dollars
	Future costs avoided	Cost of legal claims
		Operational costs (e.g. incident management costs)
		Cost for maintenance (e.g. repair, emergency works, rehabilitation)
	Access to stakeholder asset	Time taken to access asset
		Cost of accessing asset

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Benefit	Indicator	Measures
Dependable and adaptable transport network	Resilience to network changes	Amount of additional network capacity (with additional lanes or route alternatives)
		Amount of unused capacity
	Resilience to extreme events	Number or % of road closures during extreme events
		Time to return original functionality
	Resilience to changes in demand	Amount of additional network capacity
		Amount of additional load capacity
		% of road network able to accommodate heavier trucks
	Durability of assets	Design life and/or service life of an asset / system
		Time required for an asset/system to reach end of life / replacement
		Structures with high likelihood of requiring a load limit in the next 2/4/6 years (S rating)
	Range of modes	Number of transport options available to a passenger within a specified distance of their home or work
Resource efficiency	Optimisation of the tram and bus fleet	Number of additional tram and bus services run on specified routes
	Optimisation of network capacity	% of optimal capacity used (e.g. of road, bus lane, tram lane, rail line)
	Asset utilisation	Availability / downtime of assets (e.g. electrical equipment)
		Number of uses or % of time asset or system is used
	Time saved (non-travel)	Time in minutes by VicRoads staff
		Number of transactions required by VicRoads
		Average time per transaction
	Durability of assets	Design life and/or service life of an asset / system
		Time required for an asset/system to reach end of life / replacement
		Structures with high likelihood of requiring a load limit in the next 2/4/6 years (S rating)
Environmental sustainability		
A less carbon intensive transport network	Energy consumption from network assets	MJ/year
	Vehicle carbon emissions	Number of tonnes of carbon dioxide or other greenhouse gases saved (calculated using VKT, carbon content in fuel and fuel efficiencies)
	Mode shift from car	% of or number of trips made by bicycle or foot previously made by car
		% of or number of trips made by tram or bus previously made by car
	Public transport patronage	Number of patrons during a specified time period on bus, trams and/or trains on specified routes or corridors
	Connectivity between different modes of transport	Average variability in minutes of road based public transport travel
		Proportion of services that are 'on time' or service punctuality
		Distance between collection and drop off facilities
		Pedestrian travel time between modes
	Access to public transport	Minutes of delay between origin and access points

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Benefit	Indicator	Measures
Protection of environmental values	Fire risk	Fire risk rating (fuel load)
	Risk to biodiversity	Stakeholder complaints
		Number of different species present
		Number of targeted fauna species using fauna sensitive road design structure
		Number of flora and/or fauna.
		Pest complaints or sightings.
		Size of areas affected by pests.
		Number of properties affected by pests
	Water quality	Pollutant loads per hectare (pollutants of most interest are suspended solids, hydrocarbons, zinc, copper, lead, chromium)

Source: VicRoads (2015).

Tasmania: State Roads Level of Service Framework

Table B.8 Tasmanian State Roads Level of Service Framework

Key customer service outcome	Customer performance measures	Customer service output and targets				Technical performance measure
		Road category 1	Road category 2	Road category 3	Road category 4 & 5	
		Trunk Road 1A Urban 1B Rural	Regional Freight Road	Regional Access Road	Feeder Road 4A Sealed 4B Unsealed 5A Sealed 5B Unsealed	
Function	Road width	Width supports speed environment	Width supports speed environment	Width and speed environment compatible	Width and speed environment compatible	Design speed and road design parameters consistent with speed limit
		Reference Professional Services Specification T3 – Road Design Standards for relationship between road width, road category and road AADT				
	Network access	Well defined heavy freight vehicle access networks responsive to State's economic priorities Optimise access for specific industry sector requirements				Bridge structural capacity appropriate for heavy vehicle network Bridge width appropriate for heavy vehicle network Road over road bridge vertical clearance appropriate for heavy vehicle network. Road over water bridge vertical clearance provided for flood resilience Road geometry appropriate for heavy vehicle network Quality of access to major tourist attractions
		HPV access PBS 2a access subject to permit HML access Highest level crane and oversize/ overmass access Category 1B priority network for freight efficiency upgrades	HPV access PBS 2a access subject to permit HML access High level crane and oversize/ overmass access	Full access available for General and Concessional Mass Limit vehicles except for load limited bridges Individual bridge and geometry assessments for vehicle configurations that do not meet network accessibility requirements where practicable; assessments prioritised based on State economic significance	Full access available for General and Concessional Mass Limit vehicles except for load limited bridges Individual bridge and geometry assessments for vehicle configurations that do not meet network accessibility requirements where practicable; assessments prioritised based on State economic significance Some tourism access recognised as being limited by unsealed road surfaces	
	Property access	Minimise access wherever possible	Controlled/limited access; carefully managed for safety	Controlled/limited access; carefully managed for safety	Access permitted if safe	Access to/from adjacent land holdings limited as appropriate
		Limited access	Limited access	Access control primarily by planning scheme controls	Access control primarily by planning scheme controls	Reduced uncontrolled access points on Category 1 roads

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Key customer service outcome	Customer performance measures	Customer service output and targets				Technical performance measure
		Road category 1	Road category 2	Road category 3	Road category 4 & 5	
	Connectivity for communities	Primary traffic and freight routes connecting Tasmania	Tasmania's major regional roads for carrying heavy freight	The main access roads to Tasmania's regions, carrying less heavy freight than Category 2 roads	Feeder roads and other roads allowing safe travel between towns, major tourist destinations and industrial areas	Network resilience to long- and short-term disruption
		Maintain connectivity by all means necessary	Maintenance of connectivity extremely high priority	Ensure access is maintained, minimise connectivity interruptions, may require circuitous route		
		Immediate response to emergency or weather events	Rapid response to emergency or weather events	Appropriate response to emergency or weather events		
Safety	Road safety improvements	Consistent and predictable alignment	Variable road standards and alignment	Variable road standards and alignment	Variable road standards and alignment	AusRAP results for Category 1 road links to be rated for safety performance
		Targeted prevention of crashes and protection from harm in high risk areas	Lower speeds and greater driver vigilance required on some roads/sections depending on topography, access density and use	Lower speeds and greater driver vigilance required on some roads/sections depending on topography, access density and use	Lower speeds and greater driver vigilance required on some roads/sections depending on topography, access density and use	Permanent hazards identified and mitigated in a consistent and fit-for-purpose manner such that road user expectations about standard is a major factor in the ability to safely negotiate the road environment
		Reduce the risk to road users of serious injury or fatality through implementation of the safe system approach	Specific improvements targeted at high risk locations based on crash data	Specific improvements targeted at high risk locations based on crash data	Specific improvements targeted at high risk locations based on crash data	Crash data analysis
			Reduce the risk to road users of serious injury or fatality through implementation of the safe system approach	Reduce the risk to road users of serious injury or fatality through implementation of the safe system approach	Reduce the risk to road users of serious injury or fatality through implementation of the safe system approach	Regular scanning of State road crash data to identify locations where road users experience difficulty.
		Use of AusRAP modelling and infrastructure improvements to achieve a minimum 3 star rating	Trending reductions in serious injury and fatal crash data based on 5-year average	Trending reductions in serious injury and fatal crash data based on 5-year average	Trending reductions in serious injury and fatal crash data based on 5-year average	Bridge fences compliant with standards current at time of construction
		Trending reductions in serious injury and fatal crash data based on 5-year average	Appropriate road shoulders	Appropriate road shoulder and crash cluster treatments	Crash cluster treatments	
		Mass action and safe system treatments				

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Key customer service outcome	Customer performance measures	Customer service output and targets				Technical performance measure
		Road category 1	Road category 2	Road category 3	Road category 4 & 5	
Capacity	Travel speed environment	High speed Road users largely able to travel at the posted speed	Moderate to high speed Road users are able to travel at the top end of the speed limit but must negotiate isolated curves at a reduced speed	Speed to suit conditions Inconsistent alignment requiring road users to adjust their speed often to match the prevailing road conditions and alignment	Speed to suit conditions Inconsistent alignment requiring road users to adjust their speed often to match the prevailing road conditions and alignment	The optimal speed is the appropriate speed for road function, design and use. Optimal speeds support both safety and economic productivity.
		110 km/h target optimal design and posted speed	100 km/h, advisory speed to suit topography/road	90 km/h, advisory speed to suit topography/road	Advisory speed to suit topography/road	
	Journey time reliability	Majority of road users experience consistent travel times with some exceptions in urban heavy peak, holidays, during major events or during severe weather events Good overtaking opportunities provided by multi-lane roads or passing lanes Proactive management of events/incidents	Generally road users experience consistent travel times with some exceptions in urban heavy peaks, holidays, during major events or during moderate weather events Targeted passing opportunities where topography warrants Targeted event/incident management	Generally road users experience consistent travel times except where affected by other road users (all modes) or weather conditions Targeted passing opportunities where topography warrants Targeted event/incident management	Road user travel times may vary as a result of other road users (all modes), weather conditions or the physical condition of the road Targeted passing opportunities where topography warrants Targeted event/incident management	Consistency of travel times that road users experience. Incident response, network management.
		Data to be secured for five major transport corridors around the State that will be used to define the limits of acceptable journey time reliability: West Tamar Highway, CBD to Legana Launceston Southern Outlet, CBD to Breadalbane Hobart Southern Outlet, CBD to Kingston Tasman Highway, CBD to Sorell Brooker Highway, CBD to Granton Work to commence on capturing and analysing this data during FY2015/2016				

Source: Department of State Growth (2016a).

Queensland: Department of Transport and Main Roads Service Delivery Statement

Table B.9 Department of Transport and Main Roads Service Delivery Statement

Measure	2015–16 Target (set annually)
Transport system investment planning and programming	
Road system seal age – Percentage of the State-controlled road network exceeding the optimal seal age	30.4%
Road system condition – percentage of urban and rural State-controlled roads with condition better than the specified benchmark	Urban: 97-99% Rural: 95-97%
Transport infrastructure management and delivery	
Road network efficiency – Average travel time per 10km	AM peak: 11.1mins Off peak: 9.9mins PM peak: 11.3mins
Road network reliability – Percentage of the road network with reliable travel times	AM peak: 79% Off peak: 91% PM peak: 75%
Road network productivity – Percentage of the road network with good productivity	AM peak: 72% Off peak: 76% PM peak: 71%
Arterial intersection performance – Percentage of intersections congested less than 20 minutes per hour	AM peak: 87% Off peak: 94% PM peak: 82%
Number of fatal crashes on State-controlled roads per 100 million vehicle kilometres travelled where the road condition was likely to be a contributing factor	0.05
Transport safety and regulation	
Fatalities per 100,000 population on State-controlled roads	3.24
Road fatalities per 100,000 population	5.4
Hospitalised road casualties per 100,000 population	145

Source: Department of Transport and Main Roads (2016).

New South Wales: Roads and Maritime Services Business Results

Table B.10 Roads and Maritime Services Business Results

Measure	2015–16 Target (set annually)
Road fatalities per 100,000 population	≤4.4
Total recordable injury frequency rate	≤19.7
Journey time reliability – peak travel on key routes is on time	≥90%
Average incident clearance time (for 98% of incidents on major roads)	≥40mins
State Road network available to Higher Mass Limit Vehicles	N/A
NSW State Roads meeting national road smoothness standards	≥93.2
Urban State Roads meeting national road smoothness standard	≥92.4
Rural State Roads meeting national road smoothness standards	≥94.3

Source: Roads and Maritime Services (2016).

Australian Capital Territory: Roads ACT Strategic Asset Management Plan

Note: the ACT Strategic Asset Management Plan is currently under review, including the levels of service chapter. The levels of service framework includes targets for each of the next ten years, but these columns have been excluded from Table B.8.

Table B.11 Roads ACT Strategic Asset Management Plan

Service statement	**Safe and reliable Vehicle Travel**					
Levels of service	ACT motorists have access to safe, comfortable, economic, attractive, and reliable travel with sufficient capacity roads to reach their destinations					
Service attribute	Accessibility, Affordability, Quality, Reliability, Safety and Sustainability					
Links to TCCS Vision	Developing a safe and sustainable national capital that is a great place to live, to work in and visit. Ensuring to provide customers with efficient, equitable and accessible services					
Customer measure	**Source**	**Comment**	**Supporting technical measure**	**Current performance**	**Year 1 target**	**Location of performance data**
Number and severity of road accidents	Reports	Serious & Minor injury and fatalities – Annual Report	Number of serious and minor injury crashes	643 (2010)	671 (2011)	Traffic Management and Safety(TMS) unit report
Number of deaths per 100,000 population	Report	Number of fatalities		19 (2010)	6 (2011)	ACT Road Safety Strategy 2011–2020
Variation on trip to work is no more than 5 minutes	Reports	N/A	Actual travel speed	33.5 km/h	31.6 km/h (2011)	Austroads – NPI Group 7 – Travel Speed, Report May 2011
		N/A	Nominal travel speed	62.40 km/h	62.4 km/h (2011)	
		N/A	Congestion indicators	0.89 min/ km	1.02 min/ km (2011)	
		N/A	Variability of travel time	37.3%	36.8% (2011)	
	Report	Annual Budget Accountability Output 1.2d	Roughness of road pavement (IRI ≤4.2 m/km)	89% (2007)	88%	From Annual Budget performance measure output 1.2d – Road Maintenance (RM)
	Survey Austroads User Satisfaction Index	ACT residents satisfaction with the road network and road features	N/A	3.74 (2007)	3.66 (2010)	ACT resident's satisfaction with the road network and road features. Austroads USI report. Survey performed every three years

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Customer measure	Source	Comment	Supporting technical measure	Current performance	Year 1 target	Location of performance data
Attractive road infrastructure	Access Canberra	Discover report, Roads: Road defects: road pavement (sum pothole & debris count by year month)	Number of requests to improve/ address road appearance per year	1,752 (2010)	1,566 (2011)	Discover report, Roads: Road defects: road pavement (sum pothole & debris count by year month)
	Survey	N/A	Percentage of customers satisfied with the public road network	81% (June 2011)	85% June 2012	From Annual Budget Performance measure output 1.2c
Number of occurrences per month any street light not working per year	Access Canberra and/or report	Discover report, Roads: Public enquiries: Streetlight by enquirer type lights out	IAMS	1,474 (2010)	1,434 (2011)	Discover report, Roads: Public enquiries: Streetlight by enquirer type lights out
Number of occurrences per month traffic lights not operating per year	Reports	Manually collected by Traffic Signal unit monthly	Average number of major faults per month	35	42.5	Manually collected by Traffic Signal Unit monthly
Bridges are fit for purpose	Reports	Performance Output 1.2e	Number of bridges on heavy vehicle routes that meet SM1600 requirement	189	286 (2012)	Performance Output 1.2e of bridges that meet SM1600 on B Double routes

Source: Roads ACT (2013).

New Zealand: One Network Road Classification (ONRC) Performance Measures

Table B.12 NZTA One Network Road Classification Performance Measures

Outcome/Output	Aim	Measure
Safety		
Customer Outcome 1: the number of fatal and serious injuries on the network	The road and roadside are becoming safer for road users	The total number of fatal and serious injuries each year on your network.
Customer Outcome 2: collective risk	The roads and roadside are becoming safer for road users	The total number of fatal and serious injuries per kilometre each year on the network
Customer Outcome 3: personal risk	The roads and roadside are becoming safer for road users	The total number of fatal and serious injuries by traffic volume each year on the network
Technical Output 1: permanent hazards	Permanent hazards are marked consistently across New Zealand	The number of permanent hazards that are not marked in accordance with national standards RTS-5 and MOTSAM
Technical Output 2: temporary hazards	Workers and people participating in events on roads are kept safe.	The number of sites inspected and the number of audits compliant with COPTTM.
Technical Output 3: sight distances	Drivers are able to navigate safely because they can see hazards, warning signs or delineation in time to respond	The number of locations where sight distance or signs are obstructed by vegetation, unauthorised signs or other items placed within the road reserve
Technical Output 4: loss of control on wet roads	Reduce the number of fatal and serious injuries through loss of driver control	The number of fatal and serious injuries attributable to loss of driver control (including on wet roads), each year on your network
Technical Output 5: loss of driver control at night	Reduce the number of fatal and serious injuries in night time crashes	The number of fatal and serious injuries which occur in crashes at night, each year on your network
Technical Output 6: intersections	Reduce the number of fatal and serious injuries at intersections	The number of fatal and serious injuries at intersections each year on your network
Technical Output 7: hazardous faults	Reduce the number of maintenance related hazards on roads requiring evasive action by road users (e.g. detritus, ponding water, pot holes)	The number of hazardous faults which require evasive action by road users
Technical Output 8: cycle path faults	Reduce the number of maintenance related hazards on cycle paths requiring evasive action by cyclists (e.g. detritus, ponding water, pot holes, broken glass)	The number of cycle path hazards requiring evasive action by cyclists
Technical Output 9: vulnerable users	Reduce the number of fatal and serious injuries involving vulnerable users	The number of fatal and serious injuries involving vulnerable users on your network
Technical Output 10: roadside obstructions	Roadside areas are maintained free from unauthorised obstructions and new hazards are prevented from developing	The number of locations where there are unauthorised items placed within the road reserve

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Outcome/Output	Aim	Measure
Resilience		
Customer Outcome 1: the number of journeys impacted by unplanned events	The impact of unplanned events on journeys is minimised	The number of unplanned road closures and the number of vehicles affected by closures annually
Customer Outcome 2: the number of instances where road access is lost	Access to properties is available whenever practicable	The number of unplanned road closures and the number of vehicles affected by closures where there was no viable detour
Amenity		
Customer Outcome 1: Smooth Travel Exposure (STE) – roughness of the road	The smoothness of the journey reflects the ONRC classification of the road	The percentage of travel on roads smoother than the specified threshold for each classification
Customer Outcome 2: peak roughness	The smoothness of the journey reflects the ONRC classification of the road	The 85th and 95th percentile roughness of your road
Technical Output 1: roughness of the road (median and average)	The smoothness of the journey reflects the ONRC classification of the road	The median and average roughness of your roads
Technical Output 2: aesthetic faults	Manage the number of faults that detract from the customer experience (e.g. litter, graffiti, damaged or non-functioning furniture)	The number of aesthetic faults that detract from the customer experience
Accessibility		
Customer Outcome 1: proportion of network not available to: a) Class 1 heavy vehicles b) 50MAX vehicles	The trucks that need to use roads with restrictions can do so	The proportion of each road classification that is not accessible to Class 1 Heavy Vehicles and 50MAX vehicles
Technical Output 1: accessibility	Signage is fit for purpose in providing direction and guidance to road users	The number of instances where the road is not marked in accordance with national standards RTS-2 and MOTSAM and the Traffic Control Devices manual
Travel Time Reliability		
Customer Outcome 1: throughput at indicator sites	That traffic throughput is maximised on arterials and higher classifications in metropolitan areas to best satisfy demand	The hourly traffic volume during the peak morning hour and peak afternoon/evening hour

Source: New Zealand Transport Agency (2016a).

England: Highways England Performance Specification

Table B.13 Highways England Performance Specification

Performance Specification				Delivery Plan
Objective		**Measure**	**KPI target**	**Delivery Date**
Making the network safer	Key Performance Indicator (KPI)	The number of people killed and seriously injured on the network	Ongoing reduction of at least 40% by end of 2020 against 2005–09 average baseline	End of December 2020
	Performance Indicator (PI)	Incident numbers and contributory factors for motorways	N/A	Annually
	PI	Casualty numbers and contributory factors for APTRs	N/A	Annually
	PI	IRAP based road safety investigators, developed in conjunction with the Department, to feed into subsequent Route Strategies	90% of travel on the SRN will be roads with a safety rating of EuroRAP 3* (or equivalent to a new Highways England Star rating system) by the end of 2020.	Developed by March 2018
Improving user satisfaction	KPI	The % of NRUSS respondents who are Very or Fairly Satisfied	90% by end March 2017 and then maintain or improve it	90% by end March 2018
	PI	The Percentage of NRUSS respondents who are Very or Fairly Satisfied with: Journey Time; Information and Signs; Management of roadworks; Feeling Safe; Upkeep.	N/A	Monthly
	Requirement	Demonstrate what activities have been undertaken, and how effective they have been, to maintain and improve user satisfaction.	N/A	Develop during 2015
	Requirement	Support Transport Focus as it develops replacements for the NRUSS	N/A	Ongoing throughout 2015
Supporting the smooth flow of traffic	KPI	Network Availability: % of the SRN available to traffic	Maximise lane availability so it does not fall below 97% in any one year	Each year 2015/16–2019/20
	KPI	Incident Management: % of motorway incidents cleared within 1 hour	At least 85% of all motorway incidents cleared within 1 hour	Achieve in 2015/16 and maintain through 2019/20
	PI	Planning Time Index (reliability of journeys): This measure is the ratio of the 95th percentile journey time to the free-flow journey time	N/A	Monthly
	PI	Traffic (vehicle miles travelled) on the SRN	N/A	Annually

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Performance Specification				Delivery Plan
Objective		Measure	KPI target	Delivery Date
	PI	Acceptable journeys: proportion of journeys faster than ¾ of the free flow journey time, calculated as a percentage	N/A	Monthly
	PI	Average speed: The average speed of car journeys on the SRN	N/A	Monthly
	Requirement	Report annually on how the Company has minimised inconvenience to road users through roadworks over the previous year	N/A	Develop during 2015
	Requirement	Demonstrate that it is working effectively with its partners to improve incident response	N/A	Develop during 2015
Encouraging economic growth	KPI	Average Delay (time lost per vehicle)	No target	Ongoing reporting
	PI	Average delay (time lost per vehicle per mile) on Gateway Routes: the delay experienced by individual vehicles on gateway routes expressed in seconds per vehicle per mile. It is based on the difference between the actual journey time and free-flow journey time	N/A	Annually
	PI	Percentage of formal planning applications responded to within 21 days of receipt by Highways England.	99%	Annually
	PI	Meet the Government target of 25% Small and Medium sized Enterprise (SME) direct and indirect spend	N/A	Quarterly
	Requirement	Report on average delay	N/A	Ongoing reporting
	Requirement	Actively support the Construction 2025 goals	N/A	Report in Q4 of each year
	Requirement	Deliver the Roads Academy programme across the industry	N/A	Annual Report
	Requirement	Develop an approach to innovation, technology, and research and agree an implementation plan by 31 March 2016	N/A	By 31st March
	Requirement	Through Route Strategies identify constraints to economic growth that the performance of the SRN could help to alleviate and identify how future delivery and investment plans might address them	N/A	Drafts complete and submitted to DfT by 31 March

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Performance Specification				Delivery Plan
Objective		**Measure**	**KPI target**	**Delivery Date**
Delivering better environmental outcomes	KPI	Noise: Number of Noise Important Areas mitigated	At least 1,150 Noise Important Areas over RP1	TBC
	KPI	Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan. Measure to be developed	Reduction in the net loss of biodiversity by end of the first Road Period, on an ongoing annual basis.	Annually
	PI	Number of Air Quality Pilot Studies completed	N/A	Quarterly
	PI	Carbon dioxide equivalents (or CO2e) in tonnes associated with Highways England's activities	N/A	Annually
	PI	Carbon dioxide equivalents (or CO2e) in tonnes associated with the activities of Highways England's supply chain	N/A	Annually
	PI	The number of flooding hotspots and culverts (high risk and very high risk) mitigated	N/A	Annually
	PI	The number of outfalls and soakaways (high risk and very high) mitigated	N/A	Annually
	Requirement	Demonstrate what activities have been undertaken, and how effective they have been, to improve environmental outcomes	N/A	Programme by 31 March 2016, then annually report progress
	Requirement	Develop metrics covering broader environmental performance. These should include: a new or improved biodiversity metric	N/A	Programme by 31 March 2016, annual progress reports, new 'env capital' metric by 31 March 2020
	Requirement	Develop metrics covering broader environmental performance. These should include: carbon dioxide, and other greenhouse gas emissions arising from the use of the network.	N/A	Programme by 31 March 2016, annual progress reports, new network carbon metric by 31 March 2020

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Performance Specification				Delivery Plan
Objective		Measure	KPI target	Delivery Date
Helping Cyclists, walkers, and other vulnerable users	KPI	The number of new and upgraded crossings	N/A	TBC
	PI	Number of vulnerable user casualties (broken down by Cyclists, Pedestrians, Motorcyclists and Equestrians)	N/A	Annually
	PI	Identification and delivery of the Annual Cycling Programme	N/A	Annually
	Requirement	Report annually on the number of new and upgraded crossings	N/A	Ongoing
	Requirement	Develop new indicators which demonstrate improved facilities for cyclists, walkers, and other vulnerable users	N/A	Annual report
	Requirement	Report on how it is delivering against the Public Sector Equality Duty	N/A	Ongoing
Achieving real efficiency	KPI	Cost savings: savings on capital expenditure	At least £1.212 billion over RP1	TBC
	PI	Delivery Plan progress: progress of work, relative to forecasts set out in the Delivery Plan, and annual updates to the Plan, and expectations at the start of RP1	Meet or exceed 'forecasts' within the 'Delivery Plan' or subsequent 'annual updates' of that Plan.	Quarterly
	PI	CPI and SPI for schemes at Project Control Framework Stage 5 and beyond	N/A	Monthly
Keeping the Network in Good Condition	KPI	The percentage of pavement asset that does not require further investigation for possible maintenance	95% or above	Quarterly
	PI	Geotechnical Asset Inventory (Length) and Asset Condition (Feature Grade)	N/A	Quarterly
	PI	Monitor the coverage across the SRN of drainage asset inventory and condition data	N/A	Monthly
	PI	Percentage of technology asset functioning correctly. The measure represents overall availability of technology assets used for management and operation of the SRN.	N/A	Monthly
	PI	Percentage of structure on SRN that have basic inventory information and the condition of structures.	N/A	Annually

Source: Highways England (2015, 2016b).

United States: Federal Highway Administration National Performance Management Measures

Table B.14 Federal Highway Administration National Performance Management Measures

Measure	Metric	Applicability	Reporting
Number of fatalities	5-year rolling average of the total number of fatalities for each State	All public roads	Annual
Rate of fatalities	5-year rolling average of the State's fatality rate per vehicle miles travelled (VMT)	All public roads	Annual
Number of serious injuries	5-year rolling average of the total number of serious injuries for each State	All public roads	Annual
Rate of serious injuries	5-year rolling average of the State's serious injuries rate per VMT	All public roads	Annual
Number of non-motorized fatalities and non-motorized serious injuries	5-year rolling average of the total number of non-motorized fatalities and non-motorized serious injuries for each State	All public roads	Annual
Percentage of pavements of the Interstate System in Good condition	Percentage of lane-miles of the Interstate System that meet all of the following conditions: • IRI value of Interstate System is less than 95 • Cracking percentage value of Interstate System is less than 5% • For asphalt pavement, rutting value of Interstate System is less than 0.20 inches; for jointed concrete pavement, faulting value of Interstate System is less than 0.05 inches.	The Interstate System	Annual
Percentage of pavements of the Interstate System in Poor condition	Percentage of lane-miles of the Interstate System that meet two or more of the three following conditions: • For non-urbanized areas or urbanized areas with a population less than 1 million, IRI value for Interstate System is greater than 170; for urbanized area with a population of at least 1 million, IRI value for Interstate System is greater than 220 • Cracking percentage value of Interstate System is greater than 10% • For asphalt pavement, rutting value of Interstate System is greater than 0.40 inches; for jointed concrete pavement, rutting value is greater than 0.15 inches	The Interstate System	Annual
Percentage of pavements of the non-Interstate National Highway System (NHS) in Good condition	Percentage of lane-miles of the non-Interstate NHS that meet all of the following conditions: • IRI value of non-Interstate NHS is less than 95 • Cracking percentage value of non-Interstate NHS is less than 5% • For asphalt pavement, rutting value of non-Interstate NHS is less than 0.20 inches; for jointed concrete pavement, faulting value of non-Interstate NHS is less than 0.05 inches.	The non-Interstate NHS	Annual

continued...

Measure	Metric	Applicability	Reporting
Percentage of pavements of the non-Interstate NHS in Poor condition	Percentage of lane-miles of the non-Interstate NHS that meet two or more of the three following conditions: • For non-urbanized areas or urbanized areas with a population less than 1 million, IRI value for non-Interstate NHS is greater than 170; for urbanized area with a population of at least 1 million, IRI value for non-Interstate NHS is greater than 220 • Cracking percentage value of non-Interstate NHS is greater than 10% • For asphalt pavement, rutting value of non-Interstate NHS is greater than 0.40 inches; for jointed concrete pavement, rutting value is greater than 0.15 inches	The non-Interstate NHS	Annual
Percentage of NHS bridges classified as in Good condition	When the lowest rating of any of the National Bridge Inventory (NBI) items for a bridge (deck, superstructure, substructure) is 7, 8, or 9, the bridge will be classified as Good. When the rating of NBI item for culvert is 7, 8, 9, the culvert will be classified as Good	NHS	Annual
Percentage of NHS bridges classified as in Poor condition	When the lowest rating of any of the NBI items for a bridge (deck, superstructure, substructure) is 4, 3, 2, 1, or 0, the bridge will be classified as Poor. When the rating of NBI item for culvert is 4, 3, 2, 1, or 0, the culvert will be classified as Poor.	NHS	Annual
Percent of the Person-Miles Travelled on the Interstate That Are Reliable	Level of Travel Time Reliability (LOTTR[1]) – Percentage of the Interstate direction-miles of reporting segments with LOTTR <1.5	The Interstate System	Annual
Percent of the Person-Miles Travelled on the Non-Interstate NHS That Are Reliable	Level of Travel Time Reliability (LOTTR) – Percentage of the non-Interstate NHS direction-miles of reporting segments with LOTTR <1.5	The non-Interstate NHS	Annual
Percent of the Interstate System where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTTR[2]) – Percentage of the Interstate direction-miles of reporting segments with PHTTR <1.50	The Interstate System in urbanized areas with a population over 1 million	Annual
Percent of the non-Interstate NHS where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTTR) – Percentage of the non-Interstate NHS direction-miles of reporting segments with PHTTR <1.50	The non-Interstate NHS in urbanized areas with a population over 1 million	Annual
Percent Change in Tailpipe CO2 Emissions on the NHS Compared to the Calendar Year 2017 Level[3]	Total tailpipe CO2 emissions on the NHS in a calendar year (to the nearest thousand tons) over total tailpipe CO2 emissions on the NHS in the calendar year 2017 (to the nearest thousand tons)	NHS	Annual
Truck Travel Time Reliability (TTTR) Index	Truck Travel Time Reliability[4] - Percentage of the Interstate direction-miles of reporting segments with Truck Travel Time Reliability <1.50	The Interstate System	Annual
Percent of the Interstate System Mileage Uncongested[5]	Percentage of the Interstate direction-miles of reporting segments with Average Truck Speed 50 mph	The Interstate System	Annual

continued...

Measure	Metric	Applicability	Reporting
Annual Hours of Peak Hour Excessive Delay Per Capita Percent of Non-SOV Travel	Total Excessive Delay[6] - Annual Hours of Excessive Delay per Capita	The NHS in urbanized areas with a population over 1 million for the first performance period and in urbanized areas with a population over 200,000 for the second and all other performance periods that are also in nonattainment or maintenance areas for ozone (O3), carbon monoxide (CO), or particulate matter (PM10 and PM2.5)	Annual
Total Emissions Reduction	Annual Project Emission Reductions - Cumulative emission reduction due to all projects for each of the criteria pollutant or precursor for which the area is in nonattainment or maintenance	All projects financed with funds from the 23 U.S.C. 149 CMAQ program apportioned to State DOTs in areas designated as nonattainment or maintenance for ozone (O3), carbon monoxide (CO), or particulate matter (PM10 and PM2.5)	Ongoing

1 LOTTR is a comparison, expressed as a ratio, of the 80th percentile travel time of a reporting segment to the "normal" (50th percentile) travel time of a reporting segment occurring throughout a full calendar year. The 80th percentile travel time reflects the longer travel times to make a trip.

2 PHTTR is the ratio between hour that contains the longest annual average travel time during the peak period of each non-holiday weekday, and the travel time that is consistent with the intended plan and design of the roadway as part of a complete transportation system.

3 New measure in final rule

4 Truck Travel Time Reliability differs from the travel time reliability measure in that the truck travel time reliability is focused on the variability in travel times experienced by trucks during all hours of the day and throughout the year.

5 Not included in final rule.

6 See https://www.regulations.gov/document?D=FHWA-2013-0054-0092 for full discussion.

Source: National Performance Management Measures, US Federal Register no: 77 FR 5886 2 February 2017, and 82 FR 5970 17 February 2017.

Florida: Department of Transportation Performance Framework

Note: Measures not related to the performance of the road network as experienced by its users have been excluded from Table B.12.

Table B.15 FDOT Performance Framework

Goal		Measure	Metric	Target
Safety: Safe and secure travel	Core measure	Fatalities & serious injuries	five-year rolling average number of fatalities and serious injuries on all Florida roads	5% reduction each year
	Supporting measure	Fatality rate	Number of fatalities per 100 million vehicle miles travelled (VMT)	N/A
	Supporting measure	Fatalities involving lane departures and intersections	Number of fatalities involving running off the road, crossing the centre median into oncoming traffic, sideswipe crashes, vehicular rollover, and hitting fixed roadside objects; and intersections	N/A
	Supporting measure	Fatalities in construction work zones	Number of fatalities in construction work zones	N/A
	Supporting measure	Seat belt usage	Percentage of car occupants seen in annual observation survey wearing seat belt	N/A
	Supporting measure	Fatalities involving impaired drivers, aggressive and distracted driving	Fatalities involving alcohol and drugs; at least two of speeding, unsafe or improper lane change, following too closely, failure to yield the right-of-way, improper passing, or failure to obey traffic control devices; and/or manual (e.g. taking hands of the wheel), visual (e.g. taking eyes off the road), or cognitive (e.g. telephone use) distractions.	N/A
	Supporting measure	Fatalities involving at-risk drivers	Fatalities involve driver aged 65 and over, and teenage drivers	N/A
	Supporting measure	Fatalities involving vulnerable road users	Fatalities involving pedestrians, bicyclists, and motorcyclists	N/A
	Supporting measure	Commercial vehicle crash rate	Five-year rolling average number of crashes per million vehicle-miles of truck travel	N/A
	Supporting measure	Rail crossing fatalities and railroad derailments	five-year rolling average of fatalities at highway-rail grade rail crossings and those involving pedestrians; five-year rolling average of number of railroad derailments	
	Supporting measure	Fatalities involving public transit and revenue miles between safety incidents	Number of fatalities and injuries on public transit systems each year; miles travelled between safety incidents on public transit	N/A
	Supporting measure	Aviation fatalities	Five-year rolling average aviation fatalities	

continued...

Goal		Measure	Metric	Target
Preservation: Maintenance and operations	Core measure	Pavement condition	Percent of pavement on the state highway system meeting department standards, measured using surface cracking severity, roughness (IRI) and rutting severity.	80%
	Supporting measure	Percent lane miles resurfaced	Percent of planned resurfacing activates completed each year by FDOT	95%
	Core measure	Bridge condition	Percent of bridges on the state highway system having a NBI rating of 6 or higher	90%
	Supporting measure	Bridges with weight restrictions	Percent of bridges on the state highways system with posted weight restrictions	<1%
	Supporting measure	Bridge repair project contracts executed	Percentage of planned contracts for bridge repair executed each year	95%
	Supporting measure	Bridge replacement project contracts executed	Percentage of planned contracts for bridge replacement executed each year	95%
	Core measure	Maintenance	Maintenance rating of the state highways rating, a composite score from roadway, roadside, traffic services, drainage, and vegetation/ aesthetics	80%
	Supporting measure	Roadway maintenance	Composite rating evaluating potholes, edge ravelling, shoving, depressions/bumps, and paved shoulders/turnouts	N/A
	Supporting measure	Roadside maintenance	Composite rating evaluating unpaved shoulders, front slopes, slope pavements, sidewalks, and fences	N/A
	Supporting measure	Traffic services maintenance	Composite rating evaluating raised pavement markets, striping, pavement symbols, guardrails, attenuators, signs less than or equal to 30ft2, signs greater than 30ft2, object markers and delineators, and lighting	N/A
	Supporting measure	Drainage maintenance	Composite rating evaluating side/cross drains, roadside/median ditches, outfall ditches, inlets, miscellaneous drainage structures, and roadway sweeping	N/A
	Supporting measure	Vegetation/ aesthetics maintenance	Composite rating evaluating roadside mowing, slope moving, landscaping, tree trimming, curb/ sidewalk edge, litter removal, turf condition	N/A
	Core measure	Transit state of good repair	Miles travelled between breakdowns each year	N/A
	Supporting measure	ITS miles managed by FDOT	Number of miles of the state highway system covered by Intelligent Transport Systems (ITS)	N/A
	Supporting measure	Florida 511 (FL511) calls, visits, messages and alerts	Number of calls, web page views, app sessions, tweet and alerts made to/through FL511 real-time transport information service each year	N/A
	Supporting measure	Road Rangers service assists	Number of Road Ranger provided services each year	N/A
	Supporting measure	State average roadway clearance times	Time between arrival of first responder and clearance of roadway	<90mins
	Supporting measure	State average rapid incident scene clearance (RISC) times	Time between arrival of first responder and clearance of roadway for major incidents that cause completed roadway closure	<90mins

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Goal		Measure	Metric	Target
Mobility: efficient movement of people and goods	Core measure	Travel quantity	N/A	N/A
	Supporting measure	Vehicle miles of travel	Vehicle miles travelled on state highway system during peak periods each year	N/A
	Supporting measure	Vehicle miles travelled per capita	Vehicle miles travelled per capita on state highway system during peak periods each year	N/A
	Supporting measure	Combination truck miles travelled	Combination truck miles travelled on state highway system each year	N/A
	Supporting measure	Transit passenger trips	Annual transit passenger trips	Growth equal to twice the state's annual population growth
	Supporting measure	Aviation passenger boardings	Annual aviation passenger boardings each year	N/A
	Supporting measure	Seaport passenger trips	Annual seaport passenger trips	N/A
	Supporting measure	Rail passenger trips	Annual rail passenger trips on Amtrak	N/A
	Supporting measure	20ft equivalent unit (TEU) containers	Annual number of TEU containers moved through Florida seaports	N/A
	Supporting measure	Freight tonnage	Annual freight tonnage moved by truck on state highway network; annual freight tonnage moved by sea, rail and air	N/A
	Core measure	Travel quality	N/A	N/A
	Supporting measure	Level of Service (LOS)	Percent of the state highway system during peak period which met or exceeded acceptable LOS criteria	N/A
	Supporting measure	Bicycle and pedestrian LOS	Percent of the state highway system in urban areas in each bicycle LOS category (A-F); Percent of the state highway system in urban areas in each pedestrian LOS category (A-F)	N/A
	Supporting measure	Vehicle hours of delay	Total number of vehicle hours of delay during peak period on the state highway system each year	N/A
	Supporting measure	Combination truck hours of delay	Total number of truck hours of delay on the state highway system each year	N/A
	Supporting measure	Travel time reliability	Percent of travel occurring at the posted speed limit on freeways during peak period each year	N/A
	Supporting measure	Rail departure reliability	Percent of Amtrak train services departing the station within an acceptable margin of the published schedule each year	N/A
	Supporting measure	Airport departure reliability	Percent of flights departing Florida's commercial airports less than 15 minutes after the scheduled time	N/A
	Supporting measure	Transit headways	Average time between transit vehicles departing and next vehicle arriving at a stop each year. Measured for the transit system as a whole.	N/A
	Core measure	Accessibility	N/A	N/A
	Supporting measure	Commute time less than 30 minutes	Percent of people with commute times less than 30 minutes (one direction) each year	N/A

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Goal		Measure	Metric	Target
	Supporting measure	Bicycle and pedestrian facilities	Percent of the state highway system in urban areas with sidewalks, bike lanes, shoulders, or share pathways on at least one side of the road	N/A
	Supporting measure	Aviation, rail, and seaport highway LOS adequacy	Percent of the state highway system that provides connections to airports, rail terminals, and seaports, in each LOS category (A-F)	N/A
	Core measure	Utilisation	N/A	N/A
	Supporting measure	Miles severely congested	Miles of severely congested (LOS F) state highway system roads during peak period each year as percentage of whole state highway system	N/A
	Supporting measure	Travel severely congested	Percent of vehicle miles travelled in which travel was severely congested (LOS F) during peak period each year	N/A
Environment: stewardship, energy and quality places	Core measure	Air quality	Highways vehicle emissions of CO, NOx, VOC, PM2.5 and PM10 relative to 2002	N/A
	Supporting measure	Carbon Dioxide	Florida transportation sector CO2 emissions relative to 2002	N/A
	Supporting measure	Water quality – wetland mitigation	FDOT Wetland mitigation funding each year	N/A
	Supporting measure	Project screening	Cumulative number of FDOT projects screened using its Efficient Transportation Decision-Making process.	N/A
	Supporting measure	Recycling pavement	Tones of recycled pavement used in FDOT projects each year	N/A
	Supporting measure	Alternative fuel vehicles	Cumulative number of light passenger alternative fuel vehicles in FDOT's vehicle fleet	N/A
	Supporting measure	Miles of noise walls	Cumulative miles of FDOT constructed noise walls	N/A
	Supporting measure	Wildlife crossings	N/A	N/A
	Supporting measure	Designated scenic highways	Cumulative miles of designated scenic highways	N/A
	Supporting measure	Satisfaction with Florida highways	Annual percent of residents and visitors satisfied with the state highways system	N/A
	Supporting measure	Roadside attractiveness	Annual percent of residents and visitors who feel roadsides on the state highway system are attractive	N/A
	Supporting measure	Roadside kept litter free	Annual percent of residents and visitors who feel roadsides on the state highways system are litter free	N/A
	Supporting measure	Transport alternatives	Cumulative alternative transportation and transportation enhancement project funding	N/A
	Supporting measure	Transportation disadvantaged trips	Annual number of trips on public transport taken by people who are unable to transport themselves or purchase transportation because of physical or intellectual disability, income status, or age	N/A

Source: Florida Department of Transportation (2015).

Table B.16 ACCC Airport Monitoring Report, passenger-related services and facilities

Aspect	Objective criteria	Subjective criteria		
		Passenger surveys	Airline surveys	Other surveys
Airport access facilities (taxi facilities, kerbside space for pick-up and drop-off	International services • Capacity of terminal kerbside services and facilities designated for passenger pick-up and drop-off provided to landside operators such as taxis, and providers of other off-airport parking services, measured in terms of the number of standard car park spaces • Capacity of services and facilities designated for passenger pick-up and drop-off provided to the public at no charge measured in terms of the number of standard car park spaces	International services • Average rating of kerbside taxi pick-up and drop-off facilities • Average rating of taxi facilities waiting time • Average rating of kerbside space congestion	International services • Nil	International services Landside operators: • Average rating of the availability and standard of taxi facilities • Average rating of the availability and standard of kerbside space for pick-up and drop-off • Average rating of the overall system for addressing quality of service concerns • Average rating of management approach to concerns
	Domestic services • Capacity of terminal kerbside services and facilities designated for passenger pick-up and drop-off provided to landside operators such as taxis, and providers of other off-airport parking services, measured in terms of the number of standard car park spaces • Capacity of services and facilities designated for passenger pick-up and drop-off provided to the public at no charge measured in terms of the number of standard car park spaces	Domestic services • Average rating of kerbside taxi pick-up and drop-off facilities • Average rating of taxi facilities waiting time • Average rating of kerbside space congestion	Domestic services • Nil	Domestic services • Landside operators: • Average rating of the availability and standard of taxi facilities • Average rating of the availability and standard of kerbside space for pick-up and drop off • Average rating of the overall system for addressing quality of service concerns • Average rating of management approach to concerns

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Aspect	Objective criteria	Subjective criteria		
		Passenger surveys	Airline surveys	Other surveys
Car parking service facilities	International services • Average daily throughput of short term car park • Average daily throughput of long term car park	International services • Average rating of airport car parking availability • Average rating of airport car parking standard • Average rating of time taken to enter airport car park	International services • Nil	International services • Nil
	Domestic services • Average daily throughput of short term car park • Average daily throughput of long term car park	Domestic services • Average rating of airport car parking availability • Average rating of airport car parking standard • Average rating of time taken to enter airport car park	Domestic services • Nil	Domestic services • Nil
Baggage trolleys	International services • Number of passengers per baggage trolley during peak hour	International services • Average rating of findability of baggage trolleys	International services • Nil	International services • Nil
	Domestic services • Number of passengers per baggage trolley during peak hour	Domestic services • Average rating of findability of baggage trolleys	Domestic services • Nil	Domestic services • Nil
Check-in services and facilities	International Services • The number of departing passengers per: check-in desks, bag-drop facilities and spaces provided for check-in kiosks during peak hour	International Services • Average rating of check-in waiting time	International Services • Average rating of availability of check-in services and facilities • Average rating of standard of check-in services and facilities	International Services • Nil
	Domestic services • The number of departing passengers per: check-in desks, bag-drop facilities and spaces provided for check-in kiosks during peak hour	Domestic services • Average rating of check-in waiting time	Domestic services • Average rating of availability of check-in services and facilities • Average rating of standard of check-in services and facilities	Domestic services • Nil

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Aspect	Objective criteria	Subjective criteria		
		Passenger surveys	Airline surveys	Other surveys
Security inspection	International services • Number of departing passengers per security clearance system during peak hour	International services • Average rating of quality of security search process	International services • Nil	International services • Nil
	Domestic services • Number of departing passengers per security clearance system during peak hour	Domestic services • Average rating of quality of security search process	Domestic services • Nil	Domestic services • Nil
Outbound baggage system	International services • Average throughput of outbound baggage system during peak hour • Total time that the outbound baggage system was interrupted	International services • Nil	International services • Average rating of the availability of baggage processing facilities • Average rating of the standard of baggage processing facilities	International services • Nil
	Domestic services • Average throughput of outbound baggage system during peak hour • Total time that the outbound baggage system was interrupted	Domestic services • Nil	Domestic services • Average rating of the availability of baggage processing facilities • Average rating of the standard of baggage processing facilities	Domestic services • Nil
Baggage make-up, handling and reclaiming services and facilities	International services • Average throughput of inbound baggage system during peak hour • Total area (in square metres) provided by the airport operator for baggage reclaim • Total time the inbound baggage system was interrupted	International services • Average rating of information display for inbound baggage reclaim • Average rating of circulation space for inbound baggage reclaim	International services • Average rating of the availability of baggage processing facilities • Average rating of the standard of baggage processing facilities	International services • Nil

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Aspect	Objective criteria	Subjective criteria		
		Passenger surveys	Airline surveys	Other surveys
	Domestic services • Average throughput of inbound baggage system during peak hour • Total area (in square metres) provided by the airport operator for baggage reclaim • Total time the inbound baggage system was interrupted	Domestic services • Average rating of information display for inbound baggage reclaim • Average rating of circulation space for inbound baggage reclaim	Domestic services • Average rating of the availability of baggage processing facilities • Average rating of the standard of baggage processing facilities	Domestic services • Nil
Facilities to enable the processing of passengers through customs, immigration and quarantine	International services • Number of inbound Immigration desks on 30 June in the financial year • Number of baggage inspection desks on 30 June in the financial year • Number of outbound Immigration desks on 30 June in the financial year	International services • Nil	International services • Nil	International services • Nil
Flight information, general signage and public-address systems	International services • Number of passengers per flight information display screen during peak hour • Number of passengers per information point during peak hour	International services • Average rating of flight information display screens • Average rating of signage and wayfinding	International services • Nil	International services • Nil
	Domestic services • Number of passengers per flight information display screen during peak hour • Number of passengers per information point during peak hour	Domestic services • Average rating of flight information display screens • Average rating of signage and wayfinding	Domestic services • Nil	Domestic services • Nil

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Aspect	Objective criteria	Subjective criteria		
		Passenger surveys	Airline surveys	Other surveys
Public areas in terminals and public amenities (washrooms and garbage bins), lifts, escalators and moving walkways	International services • Number of passengers per washroom during peak hour	International services • Average rating of the standard of washrooms	International services Nil	International services Nil
	Domestic services • Number of passengers per washroom during peak hour	Domestic services • Average rating of the standard of washrooms	Domestic services • Nil	Domestic services • Nil
Gate lounges and seating other than in gate lounges	International services • Number of departing passengers per seat in gate lounges during peak hour • Number of departing passengers per square metre of gate lounge area during peak hour	International services • Average rating of quality and availability of seating in lounge area • Average rating of crowding in lounge area	International services • Nil	International services • Nil
	Domestic services • Number of departing passengers per seat in gate lounges during peak hour • Number of departing passengers per square metre of gate lounge area during peak hour	Domestic services • Average rating of quality and availability of seating in lounge area • Average rating of crowding in lounge area	Domestic services • Nil	Domestic services • Nil
Airport management responsiveness	Nil	Nil	Average rating of overall responsiveness or approach to addressing quality of service problems or concerns	Landside operators: • Average rating of management approach to concerns

Source: ACCC (2014b).

Table B.17 ACCC Airport Monitoring Report, aircraft-related services and facilities

Aspect	Objective criteria	Subjective criteria		
		Passenger surveys	Airline surveys	Other surveys
Ground handling services and facilities	Nil	Nil	• Average rating of the availability of ground handling services and facilities • Average rating of the standard of ground handling services and facilities	Nil
Aerobridge usage	International services • Percentage of international passengers arriving using an aerobridge • Percentage of international passengers departing using an aerobridge	International services • Nil	International services • Average rating of the availability of aerobridges • Average rating of the standard of aerobridges	International services • Nil
	Domestic services • Percentage of domestic passengers arriving using an aerobridge • Percentage of domestic passengers departing using an aerobridge	Domestic services • Nil	Domestic services • Average rating of the availability of aerobridges • Average rating of the standard of aerobridges	Domestic services • Nil
Runways, taxiways and aprons	• Total annual aircraft movements per square metre of aprons available at 30 June in the financial year • Total annual aircraft movements per square metre of runways at 30 June in the financial year	Nil	• Average rating of the availability of runways • Average rating of the standard of runways • Average rating of the availability of taxiways • Average rating of the standard of taxiways • Average rating of the availability of aprons • Average rating of the standard of aprons	Nil
Aircraft parking facilities and bays	• Total annual aircraft movements per square metre for aircraft parking bays on 30 June in the financial year	Nil	• Average rating of the availability of aircraft parking facilities and bays • Average rating of the standard of aircraft parking facilities and bays	Nil
Airside freight handling, storage areas and cargo facilities	Nil	Nil	• Average rating of the availability of airside freight handling, storage areas and cargo facilities • Average rating of the standard of airside freight handling, storage areas and cargo facilities	Nil

Source: ACCC (2014b).

Australian Rail Track Corporation Performance Indicator Reporting

Table B.18 ARTC Performance Indicators

Performance measure	Notes	Responsibility	Reporting frequency
Reliability			
Number and percentages of healthy services that exit the Network within tolerance.	A healthy service is one which: • presents to the Network within tolerance, is configured to operate to its schedule and operates in a way that it remains able to maintain its schedule; or • is running late only due to causes within the Network, but only where the root cause is outside the rail operator's control; or • is running within tolerance, regardless of previous delays. Tolerance is 15 minutes (unless otherwise agreed).	ARTC	Quarterly
Number and percentage of unhealthy services that do not deteriorate further, within tolerance.		ARTC	Quarterly
Number and percentage of services which are operated in a healthy manner.		Operator	Quarterly
Number and percentage of services which exit the Network no later than schedule, within tolerance.		Both	Quarterly
Number and percentage of services which enter the Network no later than schedule, within tolerance.		Operator	Quarterly
Number and percentage of services which exit the Network no later than one hour after schedule.		Both	Quarterly
Network Availability			
Transit Time – Infrastructure Configuration Capability	A measure of transit time over the Network, delivered by the infrastructure given its configuration (alignment, grades, curves and associated permanent speed restrictions). Measured by simulated operation of a reference Indicative Service over the Network (excluding prevailing temporary speed restrictions). Reported on the basis of average speed.	ARTC	Quarterly
Transit Time - Infrastructure Practical Capability	A measure of transit time over the Network, delivered by the infrastructure given its configuration (as measured by Transit Time – Infrastructure Configuration Capability) and maintenance requirements (including the transit time impact of temporary speed restrictions). The transit time impact of temporary speed restrictions is determined by applying the temporary speed restrictions in place on the Network to a simulation model designed to determine the total of time lost by reference Indicative Service subject to each temporary speed restriction. Reported on the basis of average speed.	ARTC	Quarterly
Transit Time – Availability to Market	A measure of transit time offered to the market, delivered by the infrastructure given its configuration, maintenance requirements and network usage (scheduled delays for path interactions). Measured by average scheduled transit time for Indicative Services adjusted for any Operator requirements (dwells, deviation from offered section run times). Reported on the basis of average speed.	ARTC	Quarterly

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Performance measure	Notes	Responsibility	Reporting frequency
Transit Time			
Number and percentage of Services which transit the Network no later than schedule transit, within tolerance.	Transit time is the difference between entry and exit times and so includes all time for all enroute activities (scheduled and actual).	Both	Quarterly
Sum of minutes delay (and minutes per hour transit) attributed to below rail cause by type of delay eg track, signals/communications, train management/control.		ARTC	Quarterly
Sum of minutes delay (and minutes per hour transit) attributed to above rail cause by type of delay eg late entry, yard/terminal, crew, locomotive, rollingstock, running.		Operator	Quarterly
Sum of minutes delay (and minutes per hour transit) unable to be attributed to a cause or beyond either party's reasonable control.		Neither	Quarterly
Temporary Speed Restrictions			
Number of kilometres and percentage of track under temporary speed restriction on the Network at the end of a reporting period.		ARTC	Quarterly
Track Condition			
Track quality measured by index.	To be measured by Track Quality Index (TQI) and averaged over each Segment. The TQI is calculated over 100m sections, using 0.5m raw data from the AK car. TQI is the sum of the standard deviations (x3) in each rail for a 20m inertial top (average over left and right rail), horizontal alignment (versine over a 10m chord (average over left and right rail)), twist over 2.0m and gauge.	ARTC	Quarterly
Unit Costs			
Infrastructure maintenance	$/track km, $/GTK Total annual expenditure associated with outsourced infrastructure maintenance and associated ARTC maintenance contract management function.	ARTC	Annually
Train control	$/train km Total annual expenditure associated with ARTC train control and transit management function.	ARTC	Annually
Operations	$/train km Total annual expenditure associated with train control and transit management functions, and ARTC operations planning and management function.	ARTC	Annually

Source: ARTC (2008).

Australia Communications and Media Authority Communications Report

Table B.19 ACMA Communications Report, Customer Service Guarantee Performance Measures

Measure	Coverage	CSG Standard time frames (working days)
Percentage and number of new service connections provided within CSG Standard time frames	Urban areas	5 (close to infrastructure), 20 (not close to infrastructure)
	Major rural areas	10 (close to infrastructure)
	Minor rural areas	15 (close to infrastructure)
	Remote	15 (close to infrastructure)
Percentage and number of in-place connections provided within CSG Standard time frames	All areas	2 days
Percentage and number of faults repaired within CSG Standard time frames	Urban areas	1 day
	Major rural areas	2 days
	Minor rural areas	2 days
	Remote	3 days
Percentage and number of appointments kept	All areas	N/A
Number of CSG exemptions for major carriage service provider	N/A	N/A

Source: ACMA 2016.

Table B.20 ACMA Communications Report, National Reliability Performance Measures

Level	Description	Target
Level 1 – national and geographical area	NRF 1a – The percentage of services that do not experience a fault, broken down into 44 field service areas	N/A
	NRF 1b – The percentage of time that services were available (that is, not waiting for repair)	N/A
	NRF 1c – Average number of hours for Telstra to restore fault-affected services in a month	N/A
Level 2 – localised cable run remediation	NRF 2 – Telstra is required to identify the 40 lowest performing cable runs (disaggregated parts of the network that comprise 10 or 100 copper wire pairs within a physical cable sheath). These are assessed over a 6 month period for remedial action	90% decrease in volume of average network events
Level 3 – individual service performance	NFR 3a, NRF 3b – Telstra is required to take action to prevent an individual CSG Standard-eligible service from experiencing more than either three faults in a rolling 60-day period (NRF 3a) or four faults in a rolling 365-day (NRF 3b).	No service experiencing more than either three faults in a rolling 60-day period or four faults in a rolling 365-day

Source: ACMA 2016.

Table B.21 ACMA Communications Report, Customer Satisfaction Survey

Aspect of communication service	Coverage		
	Fixed-line	Mobile phone	Internet
Customer service	✓	✓	✓
Service reliability	✓	✓	✓
Call/service cost	✓	✓	✓
Billing information	✓	✓	✓
Line rental cost	✓		
Internet Access		✓	
Data speeds		✓	✓
Call quality		✓	
Technical support			✓
Speed of repairing faults			✓

Source: ACMA 2016.

Water Services Association of Australia Liveability Indicators

Table B.22 WSAA Liveability Indicators

	Amenity and wellbeing	Productivity	Sustainability and future focus
Context	Days exceeding critical heat threshold** **What will this tell you?** Indicates need for urban cooling initiatives **Metric** Number of days per annum exceeding critical heat threshold	Regional GDP** **What will this tell you?** Strength of the regional economy **Metrics** TBD	Tree cover** **What will this tell you?** Tree coverage in the community, identifying areas where greening activities would be of value (e.g. less green space, corridor opportunities) **Metrics** % tree cover
		Urban growth** **What will this tell you?** The extent to which demand for water services is growing due to population growth or housing supply **Metrics** Population growth by region and by year Lot releases per month, or per annum	Canopy coverage** **What will this tell you?** It represents a way of expressing, as a percentage, how much of any given area is shaded by trees. **Metrics** Percentage of land surface area covered by trees
			Native vegetation gain** **What will this tell you?** Native vegetation increase due to bush regeneration and weed management **Metrics** Total area vegetation gain

continued...

	Amenity and wellbeing	Productivity	Sustainability and future focus
Input	Infrastructure land available for community purposes **What will this tell you?** The utility's contribution to public access to land for community uses including community gardens, bike paths, open spaces, playgrounds, etc. **Metrics** Number of ha of land available for community access Number of licences for recreational use of land	Existence of an integrated water management plan* **What will this tell you?** Relevant themes Whether water resource planning is optimised across all sources, systems and end uses **Metrics** Yes or no	Climate change adaptation program (phase) **What will this tell you?** Preparedness for the impacts of climate change (extreme events) **Metrics** % of system assessed for climate change impacts % of system assessed for climate change adaptation Risk cost of assets due to climate change impacts
	Land assessed for liveability outcomes **What will this tell you?** The utility's potential contribution to liveability through alternative use of land **Metrics** % of land assessed to land owned/occupied % of land deemed to have potential for liveability outcomes	Recycled water supplied to industry **What will this tell you?** Providing water supply options for industry to support productivity **Metrics** % of demand ML per annum	Certified to an Environmental Management System **What will this tell you?** The systems and processes that the utility has to minimise impact on the environment **Metrics** Yes or no
	Water available for parks gardens and amenity* **What will this tell you?** Extent to which demand is being met for urban greening and cooling **Metrics** % of water available compared to what is required	Contribution to WSUD/ stormwater harvesting **What will this tell you?** Schemes that the utility assists with the design, support, implementation, operation or supply of water to WSUD features in residential areas **Metrics** Record of WSUD features directly contributed Volume of water treated through WSUD features $ contributed to schemes	Water efficiency programs **What will this tell you?** Assisting customers to manage their use of water efficiently to assist in ensuring water supply security **Metrics** Number of customers involved in WE programs
	Length of paths/cycle-ways providing connectivity* **What will this tell you?** The utility's contribution to 'walkability' and recreational areas in the city. **Metrics** km of path on utility land		

continued...

	Amenity and wellbeing	Productivity	Sustainability and future focus
	Community access to lakes and waterways **What will this tell you?** The access that the community has to waterways. **Metrics** Average distance to nearest waterway from residential area		
	Assets with alternate/dual use for community outcomes* **What will this tell you?** The utility's contribution to urban amenity by making alternate use of assets through initiatives such as, street art projects, land share agreements, bike paths, etc. **Metrics** Number of ha of land available for community access		
Output	Number of complaints related to amenity **What will this tell you?** Adverse impact on public amenity **Metrics** Number of complaints related to amenity (noise, smell, visual, utility, etc.) per annum	Water service connections available to lots released* **What will this tell you?** Timeliness of connection so that the utility is not holding up development **Metrics** Water service connections available as % of lots released	Volume of water recycled **What will this tell you?** Efficient water use **Metrics** % of total wastewater ML per annum
	Sewer overflows **What will this tell you?** Adverse impact on health of waterways, public health and amenity **Metrics** Number of overflows into waterways per annum Frequency of most active overflow to each designated waterway	Value-add of projects delivered through collaboration* **What will this tell you?** Efficient delivery of projects for better outcomes **Metrics** Value added ratio $ spent to $ value delivered Energy/carbon intensity of treatment and transport	Energy/carbon intensity of treatment and transport **What will this tell you?** Energy efficiency of treatment and pumping **Metrics** % of total wastewater ML per annum
	Drinking water complaint with ADW Guidelines **What will this tell you?** Compliance to guidelines that address both the health and aesthetic quality aspects of supplying good quality drinking water. This has a fundamental impact on liveability, in access to clean drinking water. **Metrics** Number of breaches	Years to next major augmentation* **What will this tell you?** Management of operations and demand to delay major augmentations **Metrics** Years	Renewable energy generated **What will this tell you?** Waste reuse for energy (efficiency and reduced waste) and reduced reliance on mains power **Metrics** MWh % of total energy used

continued...

Amenity and wellbeing	Productivity	Sustainability and future focus
Catchment water quality risk **What will this tell you?** The risk that there will be a water quality incident in the catchment. This has a fundamental impact on liveability, in access to clean drinking water. **Metrics** Risk rating	Total lifecycle cost of network* **What will this tell you?** Efficiency of network – an asset based measure **Metrics** $/km of water or wastewater network	Nutrients/biosolids recovered **What will this tell you?** Opportunity taken to direct nutrients and soil ameliorants back to the nutrient cycle, avoiding waste or pollution **Metrics** Water use per person Volume saved
Frequency and severity of restrictions **What will this tell you?** How often customers will be required to reduce water use to reduce the impact of drought on available supplies **Metrics** Number of months Class of restrictions	Total lifecycle cost of treated water/wastewater* **What will this tell you?** Efficiency of treatment and distribution of water – a product based measure **Metrics** $/ML	Efficient water use **What will this tell you?** The efficiency of water use within the organisation **Metrics** Water use per capita Volume saved
Water supply security* **What will this tell you?** Management of water supply that reduces the impact of drought on customers (health, wellbeing & amenity), including the potential for and severity of restrictions **Metrics** Probability of reaching 40% supply volume within 5 years	Potable water use relative to target **What will this tell you?** The extent to which customer behaviours, demand management measures and water conservation initiatives are keeping demand within agreed limits **Metrics** Actual use relative to a max use per annum	Customer water efficiency **What will this tell you?** Water savings through utility water efficiency programs **Metrics** Water use per capita Volume saved
Public safety on or near water infrastructure and land* **What will this tell you?** Management of infrastructure to protect public safety **Metrics** Number of deaths and injuries per annum	Alternative water volume targets **What will this tell you?** Water efficiency and management of demand Supply capacity based on demand **Metrics** ML per annum Water supplied by source per capita vs	Greenhouse Gas Emissions **What will this tell you?** Contribution of utility to GHGs and climate change **Metrics** Tonnes
Customers assisted through hardship program **What will this tell you?** Ensuring essential services are accessibility to all **Metrics** Number assisted per 1000 customers	Operating cost **What will this tell you?** Tracks cost effectiveness and efficiency **Metrics** Cost/property serviced Total cost	Electricity consumption from renewable sources **What will this tell you?** How self-sufficient the utility is in producing power **Metrics** % total electricity consumption

continued...

Amenity and wellbeing	Productivity	Sustainability and future focus
Number of visitors to recreational areas **What will this tell you?** Use of utility land by the community for recreation. **Metrics** Number of visitors to recreational areas	Value of Agriculture using recycled water irrigation* **What will this tell you?** – **Metrics** –	Infrastructure Leakage Index (ILI) **What will this tell you?** It tells you how well the water utility has contained water loss within its system **Metrics** A recognised formula and methodology for calculating the ILI exists and is used by water utilities
	Cost of flooding above floor level* **What will this tell you?** Adverse impact of stormwater infrastructure capacity limitations **Metrics** $ cost of flooding above floor level	Environmental compliance of contractors* **What will this tell you?** The adverse impact of contractor work on the environment on behalf of the utility **Metrics** Number of non-compliances
	Travel time impacts of infrastructure failure* **What will this tell you?** Impact of infrastructure breakage and maintenance work on transport infrastructure (roads, rail, etc.) **Metrics** Hours per annum Indirect cost per annum	Length of waterways naturalised* **What will this tell you?** The extent to which adverse impact of channelization waterways is being ameliorated **Metrics** % length of total waterways % length of total waterways assessed for naturalisation % length of waterway where potential to naturalise
		Waterway quality guidelines** **What will this tell you?** The extent or frequency of waterways suffering adverse impacts on water quality **Metrics** Number of breaches of compliance limit
		Pervious surfaces* **What will this tell you?** Level of interruption of infiltration as part of the natural water cycle **Metrics** Ratio of pervious to non-pervious surfaces

continued...

	Amenity and wellbeing	Productivity	Sustainability and future focus
Outcome	Swimmable beaches **What will this tell you?** Community access to beaches with water quality safe for primary contact. Beaches are linked to receiving waters for utility managed wastewater and stormwater systems. **Metrics** % based on Department of Health/EPA assessment	Affordability of water **What will this tell you?** Impact of utility costs on the cost of water for customers relative to the cost of living **Metrics** Water bill as a % of median household income Water bill as a % of median home price	Ecological footprint for total water services **What will this tell you?** Impact on the environment **Metrics** Equivalent footprint in ha - standard WSAA member methodology
	Customer satisfaction **What will this tell you?** The extent to which customers feel their expectations of the utility have been met **Metrics** Score out of 10 based on questionnaire and statistically valid sample	Value of water dependent GDP* **What will this tell you?** Proportion of overall economic activity that is reliant on the availability and reliability of water resources **Metrics** TBD	Resilience* **What will this tell you?** Level of certainty that utility will be able to continue providing services in an uncertain world **Metrics** TBD
	Community health resulting from clean water **What will this tell you?** The underlying level of illness in the community that can be attributed to water borne disease **Metrics** Compliance with Health Based Targets based on adopted NH&MRC methodology		River health index** **What will this tell you?** Impact on receiving waters **Metrics** –

* Not currently measured by utilities but potential to be a useful metric

** Water utilities have limited influence over this indicator but it is a valuable context or outcome metric to track

Source: WSAA (2016).

Fremantle Ports Performance Management Framework

Table B.23 Fremantle Ports Performance Management Framework

Goal	Fremantle Port objectives	Key outcomes sought	Measures
Results-based service delivery Greater focus on achieving results in key service delivery areas for the benefit of all Western Australians	Providing reliable and efficient services that meet customer expectations	• Understanding and responding to customer needs • Improvements in efficiency and capability of port operations	• Annual customer survey • Equipment and berth availability • Container park utilisation rates • Loading/unloading rates • Truck turnaround times • Rail share of container trade
Financial and economic responsibility Responsibly managing the State's finances through the efficient and effective delivery of services, encouraging economic activity and reducing regulatory burdens on the private sector	Promoting and facilitating trade and business growth opportunities	• Maintaining existing trade and business and capturing new trade and business opportunities • Agreement with government on key aspects of our future business model • Fremantle Ports is positioned as an organisation focused on trade facilitation and supply chain performance, with flexibility to quickly respond to changing operating environments	• Government financial targets are met • Financial dashboard – expenditure, income, profit, rate of return, maintenance expenditure, capital works expenditure • Trade outcomes compared to budget and forecasts • Land vacancy rates
Social and environmental responsibility Ensuring that economic activity is managed in a socially and environmentally responsible manner for the long-term benefit of the State.	Ensuring business sustainability through excellent performance, innovation, business improvement and community and stakeholder engagement	• Improved safety and environmental performance • Improved stakeholder and community support • A strong level of community subscription for the strategic challenges facing the port as it is developed over time	• Environmental incidents • Lost time injuries • Annual community survey • Complaints
State building – major projects Building strategic infrastructure that will create jobs and underpin Western Australia's long-term economic development	Ensuring sound planning for all aspects of our business, including resources, services and infrastructure	• Successful completion of major infrastructure projects	• Progress priority projects

Source: Fremantle Ports (2016).

Aurizon Network Performance Report

Table B.24 Aurizon Network Quarterly Performance Report

Performance measure		Description	Coverage		
			Coal network	Bulk minerals and freight	Long distance passenger
Services that do not reach their destination on time	Due primarily to Aurizon Network	Services that do not reach their destination on time (i.e. Within the Allotted Time Threshold)	✓	✓	✓
	Due primarily to Railway Operator		✓	✓	✓
	Due primarily to other matters		✓	✓	✓
Total number of train services			✓	✓	✓
Transit time delay variance	Delays attributable to Aurizon Network	Minutes per 100 train kilometres. Delays include any variance to schedule. The delay is divided by 100 train kilometres in recognition that a 10 minute delay would be more significant to a short train journey than, for example, a two day train journey.	✓	✓	✓
	Delays attributable to Railway Operator		✓	✓	✓
	Unallocated delays		✓	✓	✓
Train cancellations	Cancellations attributable to Aurizon Network		✓	✓	✓
	Cancellations attributable to Railways Operators		✓	✓	✓
	Unallocated cancellations		✓	✓	✓
Major reportable safety incidents reported to the Safety Regulator		Does not include all safety incidents reportable to the safety regulator, but only those directly related to train services. This measure also includes those reported incidents that once investigated, are downgraded and no longer considered a major incident.	✓		
Temporary speed restrictions		The average percentage and kilometres of Aurizon Network Track (in the central Queensland coal region) under temporary speed restrictions for the month.	✓		
Overall track condition index		No methodology available.	✓		
Coal carrying train service performance		A measure of throughout for each system within the central Queensland coal region. Includes aggregate gross tonne kilometres, net tonnes, net tonne kilometres and electric gross tonne kilometres for each individual coal system.	✓		

continued...

Performance measure	Description	Coverage		
		Coal network	Bulk minerals and freight	Long distance passenger
Below rail transit time percentage	The Below Rail Transit Time is calculated as a) The relevant nominated section run times in the direction of travel as specified in the Train Service Entitlement; b) Identified Below Rail Delays; c) Time taken in crossing other trains to the extent that such time is not contributed to by Above Rail causes or Force Majeure Events; and d) Delays due to Operational Constraints directly caused by the activities of Aurizon Network maintaining the Rail Infrastructure or due to a fault or deficiency in the Rail Infrastructure provided such delays are not contributed to by Above Rail causes or Force Majeure Events. The percentage is calculated by dividing the Below Rail Transit Time by the relevant nominated section running times (in the direction of travel) as specified in the Train Service Entitlement	✓		
Coal train paths	Information on train paths for each coal system in the month for the relevant quarter. Includes train paths: available for coal carrying services; contracted for coal carrying services; scheduled by coal carrying services; used by coal carrying services; used for planned maintenance; used for unplanned maintenance; and available but not used (%).	✓		
Number of Contested Train Path decisions	The number of Contested Train Path decision making processes run each month.	✓		

Source: Aurizon (2016a).

European Union: Consumer Market Monitoring Survey

Table B.25 EU Consumer Market Monitoring Survey

Aspect	Description	Question	Response options
Comparability	how easy or difficult it is for consumers to compare goods or services as they are offered by different suppliers or providers in a market	"On a scale from 0 to 10, how difficult or easy was it to compare <the products/services> sold by different <suppliers/retailers>?"	0 to 10
Trust	the extent to which consumers are confident that suppliers, or providers, respect the rules and regulations that protect the consumer	"On a scale from 0 to 10, to what extent do you trust <suppliers/ retailers> to respect the rules and regulations protecting consumers?"	0 to 10
Problems	the occurrence of problems and asks whether consumers experienced problems with the good or service they bought or its retailers/suppliers	"Within the past <X> year(s), did you experience any problem with <the products/services> you <purchased/ paid for>, either with <the product or the retailer/the service or provider>, where you thought you had a legitimate cause for complaint?"	Yes/no
Detriment	the extent to which consumers who experienced a problem suffered financial loss or other detriment as a result	"On a scale from 0 to 10, within the past <X> year(s), to what extent have you suffered detriment as a result of problems experienced either with the <product/service> or the <supplier/ retailer>? By detriment, we mean financial loss or other types of harm (e.g. loss of time, stress, adverse health effect, etc)."	0 to 10
Complaints	the propensity to complain to the seller/provider and/or third parties if problems are experienced	"Have you complained about any of these problems?"	4 possible answers depending on whom received the complaint (provider, third party, etc.) and a "No" option
Expectations	a dimension that measures the extent to which the market meets consumers' expectations	"On a scale from 0 to 10, to what extent did on offer live up to your expectations within the past <X> year(s)?"	0 to 10
Choice	measures the level of competition and the choice of retailers/providers in a given market	"On a scale from 0 to 10, to what extent are you satisfied with the number of <suppliers/retailers> you can choose from?"	0 to 10
Importance	gauges the importance of the components comparability, expectations, trust, problems and detriment, and choice for each assessed market	"You have assessed the performance of <the market> on some key aspects. On a scale from 0 to 10, how important do you consider the following 5 aspects for <the market>?"	0 to 10 for each individual component
Switching	Assess whether consumers have changed provider in a given market within a certain timeframe (1, 2, or 3 years), the ease of switching, or their reasons for not switching. Only applicable for some service markets.	"Have you switched your <provider> in the past <X> year(s)?" "On a scale from 0 to 10, how difficult or easy do you think it was?" "Why didn't you switch?"	Yes/no 0 to 10 3 possible answers and an option to indicate a spontaneous "Other" option

Source: Consumers, Health, Agriculture and Food Executive Agency (2016).

World Bank Logistics Performance Index

Table B.26 World Bank Logistics Performance Index

Question	Response options				
In this part of the questionnaire, questions 10 to 16, you are invited to rate eight countries listed below along seven key dimensions in logistics performance. The countries have been generated based on the trading partners of your selected country of work. Based on your experience in international logistics, please select the option that best applies to each individual country against the generally accepted industry standards or practices. If you are not familiar with the clearance process in a particular country, leave that country blank.					
Rate the efficiency of the clearance process (i.e. speed, simplicity and predictability of formalities) by border control agencies, including Customs in the following countries	Very low	Low	Average	High	Very high
Evaluate the quality of trade and transport related infrastructure (e.g. ports, railroads, roads, information technology) in the following countries	Very low	Low	Average	High	Very high
Assess the ease of arranging competitively priced shipments to the following countries	Very difficult	Difficult	Average	Easy	Very easy
Evaluate the overall level of competence and quality of logistics services (e.g. Transport operators, customer brokers) in the following countries	Very low	Low	Average	High	Very high
Rate the ability to track and trace your consignments when shipping to the following countries	Very low	Low	Average	High	Very high
When arranging shipments to the countries listed below, how often do they reach the consignee within the scheduled or expected delivery time?	Hardly ever	Rarely	Sometimes	Often	Nearly always
How often do shippers ask for environmental friendly options (e.g. in view of emission levels, choice of routes, vehicles, schedules, etc.) when shipping to the following countries?	Hardly ever	Rarely	Sometimes	Often	Nearly always

Source: World Bank (2014).

Table B.27 World Bank Domestic Logistics Performance Index

Question	Response options				
In this part of the questionnaire, questions 17 to 22, you are invited to provide your assessment on the logistics environment and institutions in your country of work. The questions have been grouped according to the following themes: cost, quality of infrastructure, competence, clearance.					
Based on your experience in international logistics, please select the options that best describe the operation logistics environment in your country of work					
Port charges	Very high	High	Average	Low	Very low
Airport charges					
Road transport rates					
Rail transport rates					
Warehousing/transloading service charges					
Agent fees					
Evaluate the quality of trade and transport related infrastructure (e.g. ports, roads, airports, information technology) in your country of work					
Port infrastructure	Very low	Low	Average	High	Very high
Airport infrastructure					
Road infrastructure					
Rail infrastructure					
Warehousing/transloading facilities					
Telecommunications infrastructure and IT services					
Evaluate the competence and quality of service delivered by the following in your country of work					
Road transport service providers	Very low	Low	Average	High	Very high
Rail transport service providers					
Air transport service providers					
Maritime transport service providers					
Warehousing/transloading and distribution operators					
Freight forwarders					
Customs agencies					
Quality/standards inspection agencies					
Health (SPS (Sanitary and Phyto-Sanitary) agencies					
Customs brokers					
Trade and transport related associations					
Consignees or shippers					

continued....

Question	Response options				
Evaluate the efficiency of the following processes in your country of work					
Are import shipments cleared and delivered as scheduled?	Hardly ever	Rarely	Sometimes	Often	Nearly always
Are export shipments cleared and delivered as scheduled?					
Is the Customs clearance procedure transparent?					
Is the clearance procedure of other border agencies transparent?					
Do you receive adequate and timely information when regulations change?					
Do traders demonstrating high levels of compliance receive expedited clearance?					
How often in your country of work do you experience?					
Major delays due to compulsory warehousing/ transloading	Nearly always	Often	Sometimes	Rarely	Hardy ever
Major delays due to pre-shipment inspection					
Major delays due to maritime transhipment					
Criminal activities (e.g. stolen cargo)					
Solicitation of informal payments in connection with logistics activities					
Since 2011, have the following factors improved or worsened in your country of work?					
Customs clearance procedures	Much worsened	Worsened	About the same	Improved	Much improved
Other border-related government agencies clearance procedures					
Quality of trade and transport related infrastructure					
Quality of telecommunications/IT infrastructure					
Quality of private logistics services					
Regulation related to logistics					
Solicitation of informal payments in connection with logistics activities					

Source: World Bank (2014).

BIMCO Shipping KPI Standard and System

Table B.28 Bimco Shipping KPI Standard and System, Environmental Performance Shipping Performance Index

Shipping Performance Index	KPI	KPI Value Formula	KPI value threshold for score of zero	KPI value required for score of 100	Performance Indicator
Environmental performance	Releases of substances as defined by MARPOL annex 1-6	A+B	1	0	A: Number of releases of solid substances to the environment B: Number of oil spills
	Ballast water management violations	A	1	0	C: Number of ballast water management violates
	Contained spills	A	3	0	D: Number of contained spills of liquids
	Environmental deficiencies	A/B	5	0	E: Number of environmental related deficiencies record during external inspections F: Number of recorded external inspections

Source: BIMCO (2017b).

BCG European Railway Performance Index

Table B.29 European Railway Performance Index

Performance Index (100%)		
Intensity of use (33%)	**Quality of service (33%)**	**Safety (33%)**
Passenger volume (50%) Number of passengers multiplied by kilometres travelled divided by the country's population	Punctuality of regional trains (25%) Percentage experiences less than a 5 minutes delay	Accidents per train kilometre travelled (50%)
Goods volume (50%) Tonnes of goods multiplied by kilometres travelled divided by the country's population	Punctuality of long-distance trains (25%) Percentage experience less than a 15 minutes delay	Fatalities per train kilometre travelled (50%)
	Percentage of high-speed rail (25%) Share of long-distance traffic (number of passengers multiplied by kilometres travelled)	
	Average fare per passenger per kilometre (25%)	

Source: BCG (2017).

Abbreviations and acronyms

ACA	Australian Communications Authority
ACCC	Australian Competition and Consumer Commission
ACI	Airports Council International
ACMA	Australian Communications and Media Authority
AECM	Australian Energy Market Commission
AER	Australian Energy Regulator
AONSW	Audit Office of New South Wales
ARTC	Australian Rail Track Corporation
ASX	Australian Securities Exchange
BCG	Boston Consulting Group
BIMCO	Baltic and International Maritime Council
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BOT	Build, operate, transfer
CBO	Congressional Budget Office, United States
CHAFEA	Consumer, Health, Agriculture and food Executive Agency
CIE	Centre for International Economics
COAG	Council of Australian Governments
CPI	Consumer price index
CQCN	Central Queensland Coal Network
D&C	Design and Construct
DSG	Department of State Growth, Tasmania
EU	European Union
FHWA	Federal Highway Administration, United States
IATA	International Air Transport Association
IPART	Independent Pricing and Regulatory Tribunal, New South Wales
ITU	International Telecommunication Union
KPI	Key performance indicator
LCT	Lane Cove Tunnel
LOS	Levels of service
LPI	Logistics Performance Index
MMS	Consumer Market Monitoring Survey
MNO	Mobile network operator

MPFP	Multilateral partial factor productivity
MPI	Market Performance Indicator
MRWA	Main Roads Western Australia
MTFP	Multilateral total factor productivity
NBN Co.	National Broadband Network Company
NEM	National Electricity Market
NHS	National Highway System
NPI	National Performance Indicators
NPMM	National Performance Management Measures
NRUSS	National Road User Satisfaction Survey
NZTA	New Zealand Transport Agency
OECD	Organization for Economic Cooperation and Development
ONRC	One Network Road Classification
ORR	Office of Road and Rail, United Kingdom
PC	Productivity Commission
PI	Performance indicator
PPP	Public-Private Partnership
QCA	Queensland Competition Authority
RIS	Road Investment Strategy
RMS	Roads and Maritime Services, New South Wales
RPI	Rail Performance Index
RTA	Roads and Traffic Authority, New South Wales
SEM	Structural equation modelling
SERVPERF	Service performance
SERVQUAL	Service quality
SPI	Shipping Performance Indicator
SRN	Strategic Road Network
State DOTs	State departments of transportation
TAA	Trans Australia Airlines
TCCS	Transport Canberra and City Services Directorate, Australian Capital Territory
TfL	Transport for London
TfNSW	Transport for New South Wales
TGP	Transmission Gully Project
TMR	Department of Transport and Main Roads, Queensland
TRB	Transportation Research Board
UIC	International Union of Railways
USI	User Satisfaction Index
WSAA	Water Services Association of Australia

Glossary

Infrastructure	The term infrastructure is used here to mean economic infrastructure; that is, the physical structures from which goods and associated services are used by individuals, households and industries, including rail, roads and public transport, water and energy networks, ports and airports, and associated services. Social service infrastructure, such as schools, hospitals, prisons, public housing, etc. are not included (PC, 2014).
Levels of service (LOS)	LOS is a quantitative stratification of a performance measure or measures that represent quality of service. The LOS concept facilitates the presentation of results, through the use of a familiar ratings scales, sometimes on an A (best) to F (worst) scale, and other times through a percentage scale, or scale from 0 to 10. LOS is defined by one or more service measures that both reflect the traveller perspective and are useful to operating agencies (TRB, 2010).
Privatisation	The transfer of ownership and control of government or state assets, companies and operations to private investors (OECD, 1993). In Australia, many assets are privatised under long-term lease agreements.
Public-private partnership (PPP)	A PPP is defined as a contract between the public and private sectors where a private party delivers infrastructure and associated services over the long term and where some private financing is involved. Funding is either sourced from user charges, or from (usually long-term) government payments. Most involve the infrastructure asset returning to government ownership after a set period, unless otherwise extended (PC, 2014).

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