Vertically integrated public transport measures – executive research report

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1 Introduction

1.1 Context

This research seeks to address several issues with current approaches to public transport performance measurement in New Zealand. These include the lack of:

- a nationally consistent approach to measurement
- a common suite of best practice measures
- a consistent organising logic for measures
- an agreed definition for many existing measures.

These shortcomings make national, inter-regional, intra-regional, inter-modal and inter-operator benchmarking and reporting difficult. A more consistent measurement approach could allow better comparison between networks, and provide insights into best practice and opportunities for improvement, which could assist in delivery of a better system and improved value for money.

1.2 Research approach

Through this research, we sought to identify best-practice approaches to public transport performance measurement, evaluate the effectiveness of current practice, and recommend a comprehensive measurement approach that could be meaningfully applied to the New Zealand sector. The research was undertaken in four phases.

- Phase 1: review of literature and practice, including review of current global and local practice, and of international guidance that constitutes best practice. This phase included development of a database of potential measures that could be included in a framework.
- Phase 2: identification of gaps in current practice and opportunities for enhancement. This phase built on phase 1 to identify how current New Zealand practice compares with international best practice, and used findings from engagement with the sector to identify strengths and weaknesses.
- Phase 3: development of organising framework for measures. This phase tested various approaches to organising performance measures, and the applicability and potential for more vertical integration of measures.
- Phase 4: selection and definition of specific measures to populate framework. This phase assessed the database of potential measures developed at phase 2 to select recommended measures to populate the framework categories established at phase 3.

1.3 Scope

Our research focuses on measures for monitoring ongoing system operations (services and infrastructure), rather than measures to inform decision-making on individual public transport investment proposals. The recommended framework identifies a range of measures but not the accompanying targets or performance standards. The framework is designed to be applicable to New Zealand's core public transport system (ie, the services and infrastructure managed by public sector organisations and eligible for government funding assistance), and is not intended for monitoring passenger transport delivered on a commercial basis (eg, long-distance passenger rail or coach services).

2 Review of the literature

2.1 Measuring performance from different perspectives and for different purposes

In general terms, measures for public transport systems are used to gather information about how the system is performing. Kittleson & Associates et al. (2003) note that public transport system operations can generate vast quantities of data and measurement systems are used to make sense of this data. They identify two broad purposes for measuring performance:

- self-improvement by public transport service delivery agencies (eg, identifying shortcomings in services, measuring effects of actions previously taken, benchmarking against comparator agencies and whether goals are being met)
- communicating results (eg, information to support decisions by elected officials or communications to the public about the value of services being provided).

They highlight that the specific purposes of measures, and what constitutes public transport system 'performance', depends on the perspective from which the public transport system is viewed. They identify four key perspectives:

- customer
- community
- agency
- vehicle or driver.

The customer is interested in measures of the availability, comfort and convenience of a service. The broader community is interested in the wider positive impacts and costs of public transport. The agency will share the interests of the customer and community, but will also have interests in measures of the efficiency and effectiveness of achieving organisational goals. From the vehicle or driver perspective, there is an interest in measures of vehicle speed and reliability.

Effective measurement systems will be relevant to all four perspectives, but a common theme from the literature is the importance of measures that reflect a customer perspective. Anderson et al. (2013) argue that historically public transport operators have been focused on operational rather than customer-oriented measures and that this bias continues despite positive shifts toward measuring public transport convenience and service quality. For example, they contrast commonly used indicators of on-time service performance with more customer-oriented indicators of reliability that measure lost customer time.

2.2 Frameworks for public transport performance measurement

The international literature includes several instances of guidance for developing holistic public transport performance measurement frameworks. Kittleson & Associates et al. (2003) highlight several trade-offs that are needed in developing such a framework, including the variety, number and level of detail of measures included. While a broad variety of measures is useful for capturing the range of factors that are important for performance from different perspectives, this needs to be balanced against overwhelming audiences with too many measures, and problems with monitoring too much information and attempting to achieve too many targets. The level of detail provided needs to be sufficient to identify key issues, but too much detail can make communication challenging.

The literature provides example approaches to defining holistic measurement frameworks for public transport systems. All frameworks we reviewed categorised measures into five to ten categories. Common categories included service quality, service provision and broader impacts (including social, economic, and environmental impacts).

The breadth of measure categories included in these frameworks relates to their overall purpose. For example, the level of service framework developed by Green and Espada (2015) is focused on the user experience perspective, so some measures, such as passenger demand, are not relevant. The International Bus Benchmarking Group (2023) framework is developed from an operator perspective, so focuses on indicators relevant to internal operator organisational performance, but does not include indicators of service provision, infrastructure quality or passenger demand. Kittleson & Associates et al. (2003) is perhaps most comprehensive in establishing a menu or indicators that explicitly attempts to be relevant to multiple measurement perspectives.

2.3 Types of performance measures and qualities of effective measures

The literature also outlines the types of indicators that may be included in organising frameworks and the attributes that make measures effective. The Commonwealth of Australia (2021) notes that measures can describe a range of activities: processes, inputs, outputs or outcomes. Their guidelines suggest outcome measures are preferable to output or input measures, as they better reflect effectiveness in achieving ultimate objectives.

Gleason and Barnum (1982) suggest that public transport performance measurement systems should clearly distinguish between indicators of productivity, efficiency, effectiveness and equity. They argue that measures of efficiency and effectiveness are often conflated. They see effectiveness measures as being about the extent to which an objective has been achieved (‘doing the right thing’), while measures of efficiency are about the extent to which resources are used efficiently or economically (‘doing things right’), which are often expressed as ratios of input to output. They argue that, in current practice, measures of efficiency are often incorrectly viewed as measures of effectiveness. For example, a measure showing high performance from an efficiency perspective (eg, low operating cost per passenger kilometre) may not reflect high performance from an effectiveness perspective. They caution that poor choices of indicators to inform decision-making can lead to biases or misleading information.

Measures of equity of performance are distinct again from efficiency, effectiveness or productivity indicators. Measures of equity concern the social distribution of performance across different social groups. Bhat et al. (2005) argue that public transport performance measurement systems should disaggregate performance of public transport for different population subgroups and for different trip purposes, in the context of the importance of public transport in addressing problems of inequitable access to transport and opportunities.

2.4 New Zealand literature

Algera (2020) reviews performance measurement systems of central government transport agencies. The review is focused on measurement practices across the multi-modal transport sector, rather than on public transport specifically, but findings relevant to public transport measurement include the following.

- The importance of measuring ‘outcomes’ rather than ‘outputs’ or ‘activities’ (eg, measuring how easy is it for a customer to reach a certain destination rather than measuring kilometres of road built), but noting that output-type measures are more established in the sector, and that measuring outcomes can be more complex and suffer from data availability challenges.

- The importance of framing measures in the sector in a ‘customer-centric’ way. This includes acknowledgement of different customer groups with different needs and measuring the usability rather than simply availability of transport for more vulnerable groups.
- Effective measures have the features of simplicity, transparency, being part of a balanced indicator set, measuring positive outcomes and involving data that is practically available.

Several studies have been concerned with more specific measures relevant to public transport monitoring. For example, the strengths and weaknesses of various measures for understanding public transport reliability in New Zealand has been discussed by Vincent (2008), Ian Wallis Associates Ltd and the TAS Partnership (2013), and Rashidi et al. (2018).

Mavoa et al. (2012) and Abley and Halden (2013) discuss approaches to measuring access in New Zealand. While concerned with multi-modal access, the indicators and techniques discussed are relevant to measures of access provided by public transport. O’Fallon (2010) proposes approaches to auditing the level of accessibility (eg, physical accessibility of stops and stations) provided by public transport in New Zealand. Ian Wallis Associates (2023) uses various approaches to measuring public transport operating and capital costs in New Zealand, as well as measures of cost-efficiency and vehicle utilisation as part of research to inform the domestic transport costs and charges study.

3 Review of international practice

We reviewed international practice by assessing how seven public transport sector organisations, involved in advanced public transport systems, use and organise measures in their regular published performance reporting (see Table 1).

These organisations use a range of reporting formats and ways of organising performance measures. Several use public-facing web-based dashboards (eg, TransLink Vancouver and Translink Queensland). Many produce quarterly or annual reports that include key measures. Financial measures are generally reported through annual financial reports and accounts. Most organisations do not comprehensively collate all measures in a single location, although some, such as TransLink Vancouver provide a more comprehensive and broad-ranging set of measures collated within a single framework.

Among the organisations that we reviewed there is little commonality in the way that measures are organised (eg, the categories by which measures are grouped). Most organisations use measures derived from customer surveys to capture the customer perspective. All include measures of passenger demand, cost efficiency and financial performance that are most relevant to the provider or operator and funder. The United States Department of Transportation Federal Transit Administration's national transit database has a heavy focus on financial and efficiency measures, possibly reflecting the administration's interests as funder of public transport. Despite all frameworks including measures relevant to multiple perspectives, none of the organisations explicitly organise their measurement frameworks by these different perspectives or interest groups.

The number of measures reported on varies across the organisations, but generally ranges between 20 and 40. This number of measures possibly reflects a balance between being comprehensive, while remaining legible for audiences. TransLink Vancouver's 'accountability centre' is an example of a comprehensive measurement framework and includes approximately 35 measures organised by six categories. Transport for London's bus performance reporting involves a more narrowly focused set of bus operations and customer satisfaction measures, and includes approximately 20 operational measures and a further 20 measures of customer satisfaction.

Table 2 summarises example measures used by the case study organisations within the reporting material that we reviewed. It is organised by the same eight measure categories used to collate information from our review of international literature.

Table 1: Example measures used by case study organisations

Measure category	Transport for London (United Kingdom)	Mass Transit Rail Corporation (China)	TransLink Metro Vancouver (Canada)	Translink Queensland (Australia)	Transport for New South Wales (Australia)	Nederlandse Spoorwegen (The Netherlands)	Federal Transit Administration (United States of America)
Passenger demand	Passenger kilometres Journey stages	Passenger trips	Boardings	Passenger trips	Passenger trips	Passenger kilometres	Passenger trips Passenger miles
Service provision			Service hours per capita				Vehicle revenue miles
Service quality	% scheduled vehicle kilometres operated Average excess wait time (mins) Customer satisfaction	Number of passenger injuries per 100 million passenger trips	Customer injury rate On-time departure Customer satisfaction	On-time running Passenger injuries Customer experience	On-time running Service cancellations Customer satisfaction	Punctuality Seating opportunity Customer rating	Average speed Fatality and injury rate (per vehicle revenue mile)
Infrastructure quality			Bus stop accessibility				Station accessibility Percentage of assets in good repair
Financial	Revenue by source and expenditure by category	Revenue by source and expenditure by category	Operational cost recovery				Revenue by source and expenditure by category Farebox recovery
Broader impacts	Public transport mode share	Greenhouse gas emissions	Greenhouse gas emissions			Energy and CO^2 per passenger kilometre	

4 Review of New Zealand practice

Within New Zealand, a wide range of measures are used by public transport authorities (PTAs), public transport operators, and local and central government agencies for monitoring the performance of public transport for different purposes and at different spatial scales. Our review identified four key purposes for which measures are used by the New Zealand sector as summarised in Table 2.

Table 2: Key purposes for public transport performance measures in New Zealand

	A. Monitoring public transport operators	B. Planning and managing public transport system delivery	C. Providing regional oversight of the transport system	D. Providing national oversight of the transport system
Key agencies involved	PTAs monitoring public transport operators.	PTAs planning and managing service delivery and infrastructure performance. RCAs and other infrastructure providers planning and managing supporting infrastructure.	PTAs, regional councils, regional transport committees overseeing public transport system performance and its contribution to broader regional transport system outcomes.	NZ Transport Agency (NZTA), Ministry of Transport and other central government agencies overseeing public transport system performance and its contribution to broader national transport system outcomes.
Measures inform	Penalties and rewards for operator performance. Contract administration.	Short-to-medium term service and network planning. Short-term operational decision-making. Inter-regional benchmarking. Public communications.	Medium-to-long term public transport and multi-modal planning. Monitoring progress toward outcomes. Public communications.	Inter-regional benchmarking of PTAs. Investment decision-making. Monitoring progress toward outcomes.
Measures documented and reported on within	Contracts between PTAs and operators.	Internal PTA reporting. Regular reporting to governance groups. Public-facing dashboards.	Annual reporting to governance groups (eg, on long-term plans). Public transport and transport policy and plans (eg, regional public transport plans).	Reporting to governance groups– eg, on statements of performance expectations. National transport policy and plans.

Table 3 summarises the level of consistency in the use of measures across the four purposes and among different PTAs and other actors in the sector. Several measures are well-established, reported in a consistent way by most PTAs, and used by the NZTA for system oversight. These include, for example, measures of passenger boardings, passenger kilometres, service kilometres operated and fare revenue. Another set of measures is commonly reported on, but with more variation in definitions and the level of detail provided; for example, measures of service reliability, punctuality and various financial measures. These are reasonably consistent with the measures we identified as commonly used internationally through our review of case study public transport agencies.

There are gaps in measurement practices, with some important measures only being reported by some PTAs, and some areas of measurement where there are very different approaches to calculating similar factors. For example, measures of network coverage (eg, population within a certain distance threshold of public transport services) and of the levels of access provided by public transport (eg, proportion of jobs accessible within certain travel time thresholds) are only calculated by some PTAs and have a range of definitions.

Some aspects of service quality are infrequently measured; for example, on-board comfort factors such as crowding. This may reflect the New Zealand context where crowding is generally only an issue in major urban centres or associated with peak-period school-related demand. Infrastructure factors are also infrequently measured (eg, measures of public transport facilities or running way quality and provision). This may reflect that infrastructure factors change relatively infrequently and are therefore less relevant for ongoing measurement, and also that responsibility for public transport infrastructure often sits with organisations separate to PTAs. There are no consistently used measures of cost efficiency (eg, measures such as operating cost per passenger kilometre). NZTA has identified gaps and data availability issues in the measures collated nationally and available for its national oversight function. For example, current measures used to assess public transport infrastructure performance are seen as inadequate.

Our engagement with PTAs and operators found general enthusiasm for a more nationally consistent approach to performance measurement and clarity on measure definitions, although this was tempered by recognition of the wide diversity of contexts in which measures are used and views that measures need to locally relevant (eg, across large metropolitan contexts and smaller systems operating in regional contexts).

Table 3: Level of consistency in the use of measures across different measurement purposes and public transport authorities

<table>
<tr><th rowspan="2">Measure Category</th><th colspan="4">Measurement purpose</th></tr>
<tr><th>A. Monitoring public transport operators</th><th>B. Planning and managing public transport system delivery</th><th>C. Providing regional oversight of the transport system</th><th>D. Providing national oversight of the transport system</th></tr>
<tr><td rowspan="2">Passenger demand</td><td>N/A</td><td colspan="3">High consistency: passenger boardings, kilometres</td></tr>
<tr><td colspan="2">N/A</td><td colspan="2">Low consistency: public transport mode share</td></tr>
<tr><td rowspan="3">Service provision</td><td colspan="4">High consistency: scheduled and operated trips, service kilometres, fleet inventory</td></tr>
<tr><td colspan="4">Low consistency: workforce measures</td></tr>
<tr><td colspan="2">N/A</td><td colspan="2">Low consistency or gaps: network coverage and access</td></tr>
<tr><td rowspan="3">Service quality</td><td colspan="4">High consistency: cancellations, incident, complaints, customer satisfaction</td></tr>
<tr><td colspan="4">Moderate consistency: punctuality, reliability</td></tr>
<tr><td colspan="4">Low consistency or gaps: comfort, information provision, service frequency and travel time</td></tr>
<tr><td>Infrastructure quality</td><td>N/A</td><td colspan="3">Low consistency or gaps: facilities and running way quality</td></tr>
<tr><td rowspan="2">Financial</td><td colspan="4">High consistency: fare revenue</td></tr>
<tr><td colspan="4">Moderate consistency: expenditure, other revenue sources, private revenue share or farebox recovery</td></tr>
<tr><td>Impacts</td><td colspan="2">N/A</td><td colspan="2">Low consistency or gaps: greenhouse gas emissions, wider social and economic impacts</td></tr>
<tr><td>Efficiency</td><td colspan="4">Low consistency: productivity, cost efficiency and utilisation measures</td></tr>
</table>

5 Recommended measures framework

Our proposed framework includes two key components: an organising logic for measures and a suite of specific measures that populate the framework. We experimented with multiple organising logics and recommend a structure organised by two factors: a set of measure categories and a set of key purposes for which measures are used. The eight measure categories and 29 sub-categories communicate the breadth of elements that contribute to public transport performance and differentiate between measures of inputs, system delivery outputs and high-level outcomes. The four purposes identify relevant measures for distinct functions for which measures are used.

The 79 measures that populate the framework (see Table 4) cover the main elements that contribute to public transport performance from a range of perspectives. The recommended measures have been identified through the literature and practice review, and build on existing New Zealand practice. While the range of potential measures is wide, those selected meet our criteria of being understandable and feasible, reflecting important performance elements, and being relevant to the New Zealand context.

A subset of 30 measures has been identified as ‘headline’ measures, which are the most important measures that collectively provide a snapshot of overall performance. Headline measures are identified for each of the four key measurement purposes in the framework, and, as much as possible, are kept consistent across the purposes for which they are relevant.

Our framework also involves definitions of common ‘dimensions’ to support consistent disaggregation in reporting across different organisations and for different measurement purposes. Reporting on measures is often disaggregated; for example, measures of passenger boardings, fleet inventory, efficiency, reliability and other factors are often disaggregated by mode. Measures of passenger boardings and customer satisfaction are often disaggregated by customer segments or social groups (eg, age or gender). We define dimensions for consistent disaggregation when reporting measures. These include customer segments, modes, network components (eg, unit, route, sub-region), service type (consistent with NZTA’s ‘functional service descriptors’ classification (NZ Transport Agency Waka Kotahi, 2024)), spatial contexts and time periods.

Our measurement framework seeks to build on existing New Zealand practice. Nevertheless, we do recommend several new or modified measures that we consider have value for the sector.

- Measures of network structure and service provision, which address gaps in current practice for descriptors of the levels of public transport service provided and can contribute to benchmarking availability of services between regions.
- Expanded measures related to workforce (ie, frontline public transport operational staff such as bus drivers), building on work currently underway by NZTA and addressing the importance of workforce availability in ensuring that services are delivered.
- Measures of public transport operating speed, reflecting that travel time (which operating speed influences) is an important contributor to customer experience and that problems with operating speed can signal the need for infrastructure improvements.
- Measures of reliability that clarify definitions and introduce a new measure of ‘headway regularity’ to address deficiencies in current measures for measuring the customer experience of reliability for more frequent services. We use the term ‘reliability’ in our framework to describe an overarching category of measures within which sit a range of measures including those currently termed ‘punctuality’ (on-time performance) and ‘reliability’ (the extent to which services operate at all). This means redefining the way that the term ‘reliability’ is used compared with current practice.

- Measures of efficiency, seeking more consistency across the sector and introducing new measures that allow for cross-modal comparison by taking account of the different passenger capacities of vehicles and modes.
- Measures of public transport access and service coverage with clearer definitions that ensure increased consistency and allow for inter-regional benchmarking.

Table 4: Recommended list of measures

Category	Measure ID	Measures (*headline measure)	Data source	Relevant purpose (see Table 2)
1. Financial				
1.1 Revenue	1.1.1	Fees and charges revenue (eg, fares)*	PTA records	B, C, D
	1.1.2	Third-party revenue*		
	1.1.3	Grants and subsidies*		
	1.1.4	General and targeted rates*		
	1.1.5	Other income*		
1.2 Expenditure	1.2.1	Passenger services expenditure*		
	1.2.2	Operations and maintenance expenditure*		
	1.2.3	Public transport infrastructure improvements expenditure*		
1.3 Private share	1.3.1	Private share (private revenue as a proportion of operation expenditure)*		
2. Network				
2.1 Network structure	2.1.1	Number of routes	PTA records	C, D
	2.1.2	Route km		
2.2 Service provision	2.2.1	Scheduled capacity km*		
	2.2.2	Scheduled service km		
	2.2.3	Scheduled service trips		
	2.2.4	Scheduled service hours		
3. Fleet and workforce				
3.1 Fleet	3.1.1	Number of vehicles by capacity (as per NZTA RUB capacity classification)	PTA and operator records	C, D
	3.1.2	Percentage of vehicles by age bracket		
	3.1.3	Percentage of vehicles by vehicle type (propulsion)		
	3.1.4	Percentage of vehicles with step-free access		
	3.1.5	Percentage of vehicles with real-time audio and visual stop announcements		
3.2 Workforce	3.2.1	Workforce: actual as percentage of target*		A, B, C, D
	3.2.2	Workforce: by duration of employment		
	3.2.3	Workforce turnover: percentage of total FTE exiting workforce annually		

Category	Measure ID	Measures (*headline measure)	Data source	Relevant purpose (see Table 2)
	3.2.4	Percentage of split shifts		
	3.2.5	Number of safety and security incidents impacting passenger service staff		
4. Infrastructure				
4.1 Customer facilities	4.1.1	Percentage of stops, stations, interchanges and terminals that meet required features according to their stop classification (consistent with NZTA interchanges and stations design guidance)	PTA and local authority records	C, D
4.2 Running way	4.2.1	Km bus or special vehicle lane, or railway line in passenger service*		
	4.2.2	Proportion of scheduled bus and rail service or capacity km on dedicated or priority running way (bus or special vehicle lane or railway line)	PTA and local authority records; measures from 2.2	
5. Customer experience				
5.1 Service frequency and span	5.1.1	Percentage of customers satisfied (rating of 6+ out of 10): service frequency (last trip)	Customer survey	C, D
	5.1.2	Percentage of customers satisfied (rating of 6+ out of 10): service span (last trip)		
5.2 Travel time	5.2.1	Average operating speed*	GPS vehicle tracking	B, C, D
	5.2.2	Percentage of customers satisfied (rating of 6+ out of 10): travel time (last trip)	Customer survey	
5.3 Reliability	5.3.1	Operated (or cancelled) trips: percentage of scheduled trips operated (or cancelled)*	GPS vehicle tracking; operator records	A, B, C, D
	5.3.2	Operated (or lost) service: percentage of scheduled service kilometres operated (or lost)		
	5.3.3	On-time departure: percentage of operated trips departing from origin on time*		
	5.3.4	On-time departure: percentage of operated trips departing from intermediate timing points on time*		
	5.3.5	On-time departure and arrival: percentage of operated trips departing from origin and arriving at destination on time*		
	5.3.6	Headway regularity: percentage of trips arriving between x% and x% of scheduled headway (eg, 0%–120%)*		
	5.3.7	On-time satisfaction: percentage of customers satisfied (rating of 6+ out of 10): last trip arriving and departing on time*	Customer survey	
5.4 On-vehicle comfort	5.4.1	Percentage of peak-period services crowded (peak number of passengers onboard each service exceeds 100% of seats available)	Ticketing data; operator records	A, B, C, D
	5.4.2	Percentage of customers satisfied (rating of 6+ out of 10): on-board vehicle comfort on last trip*	Customer survey	

Category	Measure ID	Measures (*headline measure)	Data source	Relevant purpose (see Table 2)
	5.4.3	Percentage of customers satisfied (rating of 6+ out of 10): vehicle condition on last trip		B, C, D
	5.4.4	Percentage of customers satisfied (rating of 6+ out of 10): vehicle accessibility on last trip		
5.5 Facilities comfort	5.5.1	Percentage of customers satisfied (rating of 6+ out of 10): stops, stations and terminals quality*		C, D
	5.5.2	Percentage of customers satisfied (rating of 6+ out of 10): stops, stations and terminals accessibility		
5.6 Customer information	5.6.1	Percentage of customers satisfied (rating of 6+ out of 10): information available to help you plan and manage your journey on last trip		
5.7 Safety and security	5.7.1	Number of deaths and serious injuries on public transport	NZTA crash analysis system; PTA records	B, C, D
	5.7.2	Number of serious security incidents	PTA and operator incident register	
	5.7.3	Percentage of customers satisfied (rating of 6+ out of 10): safety and personal security on last trip*	Customer survey	A, B, C, D
5.8 Financial cost to customer	5.8.1	Average fare per passenger km	Derived from measures in categories 1.1 and 6.1	C, D
	5.8.2	Cost to customer (for average distance public transport trip or per passenger km): private passenger vehicle operating cost as a percentage of average public transport fare	Derived from measures in categories 1.1 and 6.1 and private vehicle operating cost data	
	5.8.3	Percentage of customers satisfied (rating of 6+ out of 10): value for money of fare, last trip	Customer survey	
5.9 Overall customer experience	5.9.1	Percentage of customers satisfied (rating of 6+ out of 10): overall trip (last trip)*	Customer survey	A, B, C, D
	5.9.2	Percentage of customers satisfied (rating of 6+ out of 10): access to public transport stop from journey origin		C, D
	5.9.3	Percentage of customers satisfied (rating of 6+ out of 10): access to public transport stop to journey destination		
	5.9.4	Complaints*	PTA and operator complaint register	
5.10 Wider community perceptions	5.10.1	Community perception of public transport	Community survey (eg, NZTA Journey Experience Monitor)	A, B, C, D
6. Service use				

Category	Measure ID	Measures (*headline measure)	Data source	Relevant purpose (see Table 2)
6.1 Passenger demand	6.1.1	Boardings*	Ticketing data	B, C, D
	6.1.2	Passenger km*		
	6.1.3	Percentage of population using public transport by range of time periods	Community survey (eg, NZTA journey experience monitor)	C, D
6.2 End-to-end journey	6.2.1	Percentage of customers by mode of access and egress to stop, station or terminal (last trip)	Customer survey	
6.3 Mode share	6.3.1	Public transport mode share (journeys to work and education)*	Census	
	6.3.2	Public transport mode share (passenger km)	Household travel survey	
7. Efficiency				
7.1 Service utilisation	7.1.1	Boardings per service hour	Derived from measures in 6.1 and 2.2	B, C, D
	7.1.2	Boardings as percentage of capacity		
	7.1.3	Passenger km as percentage of capacity km*		
7.2 Cost efficiency	7.2.1	Operating cost per passenger km	Derived from measures in 6.1 and 1.2	
	7.2.2	Operating cost per service km	Derived from measures in 2.2 and 1.2	
	7.2.3	Operating cost per unit of capacity km*	Derived from measures in 2.2 and 1.2	
8. Transport outcomes				
8.1 Healthy and safe people	8.1.1	Number of deaths and serious injuries on public transport [repeated from 5.7]	NZTA crash analysis system	C, D
	8.1.2	Number of deaths and serious injuries per passenger km: ratio of private passenger vehicle to public transport	NZTA crash analysis system; public transport passenger km from measure in category 6.1; vehicle passenger km from household travel survey	
8.2 Resilience and security	8.2.1	Operated (or cancelled) trips: Percentage of scheduled trips operated (or cancelled) [repeated from 5.3.1]	GPS vehicle tracking; operator records	
	8.2.2	Number of reported serious security incidents per passenger km [repeated from 5.7]	PTA; operator incident register; passenger km from measure in category 6.1	

Category	Measure ID	Measures (*headline measure)	Data source	Relevant purpose (see Table 2)
8.3 Economic prosperity	8.3.1	Percentage of jobs in region within 30 and 45 minutes door-to-door travel time for the average resident, AM peak*	Public transport network from PTA network and schedule data; jobs and resident population from Census	
	8.3.2	Percentage of jobs in region within 30 and 45 minutes door-to-door travel time for the average resident, AM peak: ratio of private passenger vehicle vs public transport	As above; private vehicle access from regional transport models	
8.4 Environmental sustainability	8.4.1	Average grams carbon dioxide emitted per passenger km	Requires further investigation	
	8.4.2	Greenhouse gas emissions (grams carbon dioxide per passenger km): ratio of private passenger vehicle to public transport		
8.5 Inclusive access	8.5.1	Percentage of population living within 400 m and 800 m of a public transport stop via footpath network	Population and jobs from Census; public transport stops form PTA records	
	8.5.2	Percentage of jobs within 400 m and 800 m of a public transport stop via footpath network		
	8.5.3	Percentage of population and jobs (combined) within 400 m and 800 m of a public transport stop via footpath network		
	8.5.4	Percentage of population within 30 min and 45 min public transport travel time (AM peak) to an activity centre*	Public transport network from PTA network and schedule data; population from Census; activity centres from local authority plans	
	8.5.5	Access to destinations: community perception	Community survey (eg, NZTA journey experience monitor)	

6 Discussion

While we have identified a coherent and logical measurement framework, there are multiple alternative ways in which a framework could be organised and an even wider range of specific measures that could populate our measure categories. The research is intended to inform development of improved measurement practices by the New Zealand public transport sector, and any framework that might be implemented by the sector could entail further evolution of what is recommended. We expect that any such process would involve further collaboration and engagement between key sector participants, including operators, PTAs and relevant government agencies.

Opportunities for 'vertical integration' and increased consistency in the use of measures across the sector is a key objective of this research. The framework achieves this by identifying common measures that are applicable to multiple purposes and clarifying their definitions. Ensuring increased consistency in practice will require careful implementation of any new measurement framework across a decentralised sector. There are several methods to support this, including the following.

- Providing guidance on measurement from NZTA to PTAs, potentially including mandated approaches, building on recent strengthened guidance to the sector.
- Using centralised data processing to automate measurement, which would minimise the burden on PTAs and ensure that measures are calculated in a consistent way across the country. For example, the imminent introduction of the national ticketing system provides a clear opportunity for increased central collation of data related to public transport service use, which could allow some measures, such as boardings and passenger kilometres, to be centrally calculated and disseminated.
- Developing centrally managed tools to calculate more complex measures, such as those that rely on geographic information system (GIS) analysis (eg, service coverage and public transport access), which would similarly minimise the burden on PTAs and ensure consistency.
- Training and knowledge-sharing across the sector that helps communicate the value of enhanced measurement processes and assists in managing analytic and data collection effort.

Our recommended set of measures builds on those in common use. Where we have recommended measures that are not in common use, we have selected those that are feasible to collect and sought to limit the range of data sources required.

Most recommended measures can be derived from a reasonably small number of data sources, for example customer and community surveys (already established in existing practice), ticketing data and vehicle tracking data. Several of the measures will rely on comprehensive data collection and record keeping by PTAs, operators and infrastructure providers, and some of the more complex measures involve combinations of multiple data sources and use of analytic tools, such as GIS. While implementing the framework may involve more effort in collating data, analysis and reporting there is potential for considerable value from more informed sector decision-making, which can ultimately lead to better outcomes for public transport customers, agencies, funders and the broader community.

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