Traffic Operations Centres

New Zealand Transport Agency

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Contents

Glossary

ATOC	Auckland Traffic Operations Centre
BCR	Benefit-cost ratio
CCC	Christchurch City Council
CCTV	Closed-circuit television
CTOC	Christchurch Traffic Operations Centre
EEM	Economic Evaluation Manual
FTE	Full-time equivalent
FY	Financial year
ITS	Intelligent transport system
NLTP	National Land Transport Programme
NZTA	New Zealand Transport Agency
OSM	Operational systems management
TOC	Traffic Operating Centre
VCR	Volume-to-capacity ratio
VMS	Variable message sign
VOC	Vehicle operating costs
WTOC	Wellington Traffic Operations Centre

1. Executive summary

This report summarises our findings in relation to the development of a framework to quantify the benefits provided by the operation of New Zealand Transport Agency's (**NZTA**) three Transport Operations Centres (**TOCs**). This analysis will support the preparation of business cases for the National Land Transport Programme (**NLTP**), specifically business cases relating to investment in or funding of each of NZTA's TOCs, located in Auckland (**ATOC**), Wellington (**WTOC**) and Christchurch (**CTOC**).

The findings are supported by an Excel workbook for each TOC which have been used to calculate the benefit-cost ratios (**BCR**) described in this report and the associated assumptions and information.

The TOCs perform four key functional activities. These include:

- optimisation;
- real time travel information;
- unplanned incident management; and,
- planned network activities.

These four key functional activities comprise the main purpose of the TOCs. The functional activities are supported by two enabler categories, being operational systems management and intelligent transport systems (**ITS**) asset management.

The key benefits categories were assessed to be related to travel time, congestion and reliability cost savings, with less significant benefits including crash, emissions, and vehicle operating costs (**VOC**) savings.

The benefits are unable to be mapped to functional activities on a one for one basis as the benefits are derived from each of the functional activities working in tandem to deliver network-wide outcomes. This aligned to numerous studies commissioned by NZTA which tended to analyse traffic management systems as integrated network activities, resulting in benefits to users of the network. Consequently, and despite the costs being mapped to functional activities, the benefit-cost ratios can only be derived at the overall individual TOC level using the benefit and cost tools, rather than at the functional activity level. It would however be possible to calculate BCRs at a sub-network level if the supporting benefit data was available.

The network data required to quantify the benefits described above is not readily available currently. Data was either not measured by the TOCs and/or NZTA, or it was not held in a format that could readily be extracted without a significant time investment. In the absence of this data, certain benefits are not able to be quantified using the benefits worksheets.

Incident data was provided by CTOC and WTOC, however, it was difficult to distinguish between initial incidents and secondary crashes related to incidents. Therefore, this section of the workbook was left empty, and a recommendation has been included in Section 8 to classify all incidents in a manner that would allow this type of incident to be readily identified for this type of analysis.

Limited information was provided for measuring the travel time benefits associated with the TOCs. Travel time data was provided for each of the TOCs based on studies performed on key network routes during 2016. This data was limited by the number of routes analysed by each TOC; with the CTOC study (22 roads measured) being significantly more comprehensive than the ATOC (seven roads) and WTOC (three roads) studies. Notwithstanding these limitations, this data was used in the analysis to provide an indication of the magnitude of the BCR ratios for each of the TOCs, noting that including network data for the congestion and reliability benefits, if this was available, would increase the ratios for each TOC.

The net effect of the data limitations is that BCRs most likely understate the benefits. The analysis performed indicates CTOC has the highest BCR at **8.3**, followed by ATOC (**5.1**) and WTOC (**3.5**). These ratios are shown in the table below. The ratios were likely distorted by the number of studies performed on each network as the total number of vehicles on the road network (being a significant contributor to the output of this calculation) would likely be understated in Wellington and Auckland. Wellington is particularly problematic given the wide area of operational coverage. However, the ratios provide an indication of the potential level of benefit provided by the TOCs' operations.

Total TOC benefit-cost ratio

	ATOC	WTOC	CTOC
Total benefits	126.24	35.11	64.54
Total costs	24.70	9.94	7.78
Benefit-cost ratio	**5.11**	**3.53**	**8.30**

International literature reviewed in a NZTA research report (NZTA Report 594, 'Demonstrating the benefit of network operations activities', Jun 2016) indicated BCR results for various network operations including network monitoring, real-time operations, travel information, and temporary traffic management, of at least **4.0**, with some indicating results of higher than **10.0**.

A study of an incident management system implemented on Auckland's North Shore that uses traveller information and intelligence monitoring to develop alternative routes during incidents estimated a BCR of between **7.0** and **8.0** for this system. Additionally, a CTOC study that tested the impact of signal optimisation on key arterial routes found BCR ratios of greater than **10.0**. One particular study on signal optimisation at the intersection of Blenheim and Curletts Roads estimated a BCR of **65.0**. Another study by CTOC on the impact of traveller information and incident response management on congestion estimated that these activities generated a BCR of greater than **10.0**.

It is worth noting that the BCR values tended to be for individual schemes, however the indicated high BCR values for these schemes imply that the combination of the TOC functional activities would likely derive a high BCR value.

2. Scope and approach

Scope

Deloitte has been engaged to assist New Zealand Transport Agency (**NZTA**) in undertaking necessary analysis to support preparation of business cases for the National Transport Programme (**NLTP**), specifically business cases relating to investment in or funding of each of NZTA's three Transport Operations Centres (**TOCs**), located in Auckland (**ATOC**), Wellington (**WTOC**) and Christchurch (**CTOC**). In order to articulate the potential costs and benefits of the TOCs, NZTA wishes to better understand the activities and associated costs performed by the TOCs, and the potential benefits provided by these activities.

Given this purpose, the scope of our engagement is to work with NZTA and the TOC managers to develop potential inputs to support the financial and economic case for NZTA's TOC section of the NLTP business case, and a framework for assessing the potential costs and benefits of the current TOC operations.

The outputs will include:

- a workbook setting out the costs and, where possible, quantified benefits of existing operations by TOC functional activity; and
- a detailed methodology setting out: the functional activities by TOC and a clear definition for each, as agreed by the TOC managers; the process for adding or removing tasks; the process for quantifying existing benefits and, where applicable, quantifying future benefits; and, a detailed per TOC cost allocation methodology, assumptions applied and any international benchmarks used to estimate cost allocation.

Approach

Our approach was to:

- Interview each of the TOC managers and agree as a group the core functional activities performed by the TOCs. These were refined into four key functional activities, which together are the main purpose of the TOCs, as well as two core enablers or underlying requirements for TOC operations. Each of the key functional activities was agreed to be a core service of the TOCs. A list of tasks included within each key functional activity was also obtained from each of the TOCs, with any key differences between tasks performed by TOCs noted.
- Once the TOCs had agreed on the key functional activities, the full cost budget for a single year (2016/17) was analysed, line by line, in order to allocate each cost line item to a core functional activity or enabler. This was done through assessing which cost lines could be directly attributable to an activity through its nature, which cost lines were general TOC enablers, or which cost lines were driven by TOC employee time and allocated to functional activities based on an analysis of full-time equivalent (**FTE**) time.
- Total costs of each functional activity and proportions were reviewed by TOC managers and NZTA for reasonableness and adjusted as necessary.
- A literature review was undertaken on studies of traffic services and the impacts of congestion and incidents. The review included studies commissioned by NZTA available on the NZTA website, and Australian studies including Austroads. The Economic Evaluation Manual (**EEM**) was also reviewed to determine suitable base values and benefit calculation methodologies to apply to the TOC services.
- Using the EEM, data available from TOCs, and evidence from international studies, a benefits methodology worksheet was designed, including parameters from the EEM, input cells for TOC and NZTA specific network information, and calculations to determine the resultant benefits.
- The total benefits from TOC functional activities was compared against the costs of the TOCs to determine benefit-cost ratios (**BCR**) for the TOCs.

- The benefits and costs workbook was provided to the TOCs and NZTA to use in future years or as new data becomes available to use in the calculations.
- Outline recommendations for NZTA to implement to better understand the operations of the TOCs, including the costs and benefits associated with the TOCs.

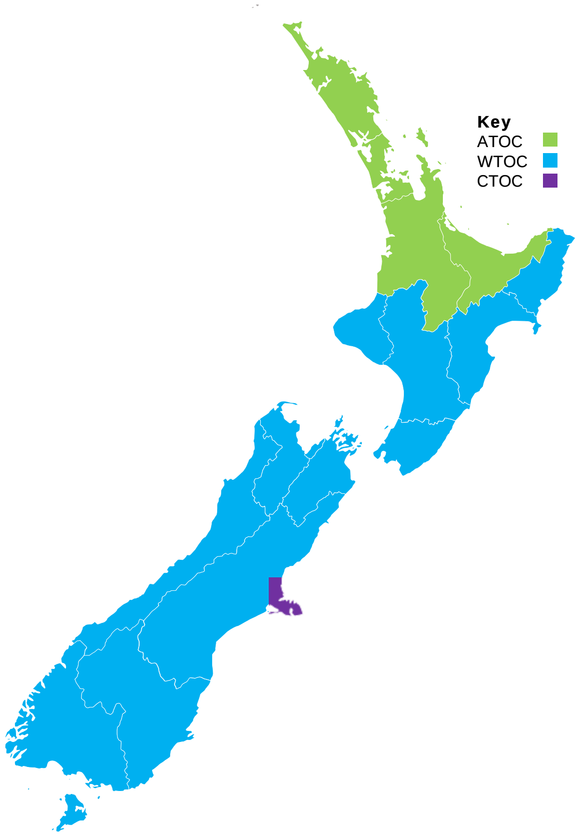
Typically BCR analysis is performed on an NPV basis, whereby the future benefits and costs over a period of time are discounted to develop BCR values. This approach tends to be more common for analysis of projects, as costs are often front-ended while benefits follow later. For example, an NPV based BCR analysis would be appropriate for a new software system implemented by the TOCs.

Given the lack of reliable forecasted / projected costs beyond 2016/17, and the nature of the TOCs (having been operating for over five years), our approach detailed above is a reasonable method for providing an indication of the benefits provided by the TOCs. However, given the expected growth in vehicle kilometres travelled within New Zealand, it is likely that the BCR values generated by this approach would be lower than the BCR values derived from an NPV based approach, therefore understating the benefits of the TOCs.

3. Overview of activities

Area covered

The area serviced by each of the TOCs varies significantly. The map below illustrates the area covered by each TOC's operations.



ATOC

ATOC's area of operations includes the state highways in Northland, Waikato and the Bay of Plenty, and the entire road network in Auckland. The road network covered by ATOC comprises 11,000 kilometres.

WTOC

WTOC is responsible for the blue area on the map above. This area includes 80% of New Zealand's land area and 73% of its state highways.

CTOC

CTOC is responsible for the roads in Christchurch and Banks Peninsula. CTOC also provides the following services outside of the above area:

1. Traffic signal monitoring, optimisation (recurrent events), operations (unplanned and planned events), CCTV monitoring, and administering maintenance, asset records and renewals for all signals on the roads covered by the Timaru, Ashburton, and Waimakariri District Councils.
2. Developing traveller information for the whole of the South Island.
3. CTOC supports WTOC with unplanned incident management for the wider South Island (but leads in Christchurch and Banks Peninsula).
4. Temporary traffic management coordination and approval for all works that cross the Waimakariri District, Christchurch City and Selwyn District boundaries.

Overview

Each TOC performs a large number of individual tasks on a daily basis. While the tasks aren't identical across the TOCs, we were not provided with a full list of tasks for each TOC to demonstrate the difference in tasks between the TOCs. However, the tasks can be broadly categorised under the following functional activities:

- optimisation;
- real time travel information;
- incident management; and
- planned network activities.

These key functional activities align with international studies describing the services performed and key functions of traffic network management.

An additional two categories have been identified as accounting for a large proportion of the costs, being operational systems management and intelligent transport systems (**ITS**) asset management. These two categories have been identified as enablers, as they are categories that support the four functional activities. The cost lines that relate to these enablers that support all four functional activities have been shown separately as they may fluctuate based on level of asset renewals and may not relate to specific activities. The TOCs may wish to allocate these costs to the activities in future using a proportion of use method. The remaining enablers cost lines that relate to specific functional activities have been directly attributed to the relevant functional activity.

The ITS asset management and operational systems management enablers include asset renewals which relate to the national infrastructure overseen by NZTA. It therefore would likely be incurred regardless of TOC activity and is instead an allocation by NZTA to the TOC.

Cost data was only provided for a single year (2016/17). While this data may be representative of a typical year, and therefore the average annual cost over time, we were not able to verify this. The 2016/17 data has been assumed to be indicative of average annual spend over time. The cost data includes the operating costs and capital expenditure related to the TOCs, but does not include depreciation.

Optimisation

The optimisation function involves supporting the efficient movement of people and goods through the transport system. The TOCs utilise technology and data to facilitate the management of demand from travellers within the road network and enable vehicles to make the most efficient use of the urban and rural road networks. The data collected aids the implementation of demand management strategies that aim to re-distribute traveller demand between nodes in the road network and ideally to other modes of transport.

The tasks included within the optimisation function are:

- monitor, collect and store traffic data;
- develop demand management strategies;
- use ITS assets to influence traffic flow;
- provide advice on where infrastructure / systems should be implemented (e.g. traffic signals and passing lanes);
- work with contractors (e.g. tunnel operators) to maintain and enhance network capacity; and
- support councils with public transport initiatives.

Real time travel information

This function relates to the provision of information to travellers about traffic conditions, including other available routes and times, to influence travellers' choices about their mode, route and time of travel.

The tasks included within the real time travel information function are:

- monitor traffic, event and weather information;
- provide up-to-date traffic information to customers through electronic mediums such as Twitter and Facebook;
- plan special routes for emergency and goods vehicles; and
- use roadside assets to inform customer journeys.

Incident management

The incident management function involves managing the response to and minimising the impact on customer journeys from unplanned incidents. This activity relies upon coordinated incident management. Specifically, this activity relies upon the identification and classification of incidents, and planning intervention that minimises the impact of unplanned incidents on customers' ability to efficiently navigate the road network.

The tasks included within the incident management function are:

- collect, filter and classify incident notifications from a variety of sources;
- initiate, plan and implement appropriate responses to incidents;
- manage contracts with external contractors;
- coordinate response teams, including emergency services;
- redirect traffic to minimise disruption and further incidents; and
- support the response to civil defence events.

Planned network activities

Planned network activities involves planning and preparing the road network to effectively and efficiently cope with planned events to minimise the disruption to road users' journeys. This includes road works, road closures and other events (e.g. significant concerts) which may disrupt normal traffic.

The tasks included within the planned network activities function are:

- work with councils to plan the road network for events;
- liaise with contractors to support road work activities;
- liaise with event organisers (e.g. cricket world cup matches);
- plan and implement alternative routes;
- communicate event information to customers;
- coordinate with organisers of events;
- place signs and signals to alert passengers on the network; and
- CTOC also approves applications for planned and special events.

Operational systems management

The operational systems management enabler involves operating, maintaining, improving, and enhancing the core internal operational software systems that enable the TOC activities to function.

ITS asset management

The ITS asset management enabler involves operating, maintaining, improving, and enhancing the physical out-of-office ITS infrastructure, such as parking cameras, closed-circuit television (**CCTV**), and variable message sign (**VMS**), to enable the TOCs to perform the above functional activities.

4. Costs

Overview

The cost worksheets of the framework consider the average annual funding request for each of the TOCs. This should ideally be an average of the funding request amounts for the next five to ten years, as this would avoid one-off significant costs (such as maintenance and renewals cost categories) distorting the BCR results. The funding requests include the operating costs and capital expenditure related to the TOCs, but do not consider depreciation.

The cost worksheets for each of the TOCs have been populated with cost data from the 2016/17 annual plans. The TOCs do not currently undertake any maintenance and renewals planning, despite these costs making up a large part of the TOCs' funding requirements. Consequently, the TOCs have limited visibility regarding the required maintenance and renewals funding required beyond the next financial year.

The current funding requests forecast year on year decreases in maintenance and renewals expenditure beyond the next financial year; this trend seems unrealistic. Additionally, the portion of ATOC and CTOC funding provided by Auckland Transport and Christchurch City Council, respectively, is only forecast for one financial year. Therefore, while the current year funding request might be impacted by greater or lower than average cost categories, the 2016/17 funding requests are the best available view on the average annual cost of the TOCs.

The funding structures differ between the TOCs; WTOC is wholly funded by NZTA, while ATOC and CTOC are jointly funded by NZTA and, respectively, Auckland Transport and Christchurch City Council (**CCC**). The total funding request of each individual TOC has been included in the analysis.

The individual cost categories from the annual plans have been allocated to the functional activities and enablers. Cost categories that directly support specific functional activities or enablers were allocated to the respective category, while the indirect costs were allocated using one of the following indirect cost allocation mechanisms:

Direct cost categories

- optimisation;
- real time travel information;
- unplanned incident management;
- planned network activities;
- operational systems management; and
- ITS asset management.

Indirect cost allocation mechanisms

- allocated evenly between functional activities;
- allocated to functional activities and enablers based on FTE composition; and
- allocated based on other percentage split (as defined by the TOC managers) to functional activities and enablers.

The annual plan cost data isn't in a format that allows most costs to be allocated to individual tasks. While this level of detail would be useful to provide context around the tasks that require the most resources, it may not be beneficial from a benefit-cost analysis context. The main reason for this is that the benefit measures described in the next section don't easily map to functional activities. The measures take a whole-of-system view as the functional activities and enablers overlap to deliver the outcomes of the TOCs.

Benefits of an integrated, well running network are the result of multiple measures and functional activities which together provide greater reliability and lower congestion. Similarly, the functional activities and tasks performed by TOCs are not undertaken in isolation. Allocations have been made to estimate and demonstrate the potential costs of various activities, however, they cannot be reliably allocated to individual tasks.

Staff employed by the TOCs work across many tasks and functional activities each day without recording time sheet data or being allocated to a specific task. This means one FTE may work across all four functional activities and both enablers during a day. Furthermore, a significant portion of the costs is from renewing assets and equipment. Although asset renewals do not demonstrate a core service of the TOC, the underlying assets are necessary for the TOCs to perform their functional activities. In the event of equipment faults or IT system crashes, the TOCs would be unable to perform their core functional activities and all benefits of the TOCs may be lost.

The cost allocations shown below highlight the significance of the TOCs' investment in the operational systems management and ITS asset management enablers. An allocation of the costs associated with these enablers based on the proportion of time the underlying systems are used to support each functional activity would provide a more accurate view of the cost of each functional activity. However, this has not been done for the purposes of this analysis as we understand this would be a cumbersome task given the number of different systems supporting the functional activities across the TOCs.

Allocation of costs

This section outlines the allocation of the FY16/17 annual plan cost data to each of the functional activities and enablers.

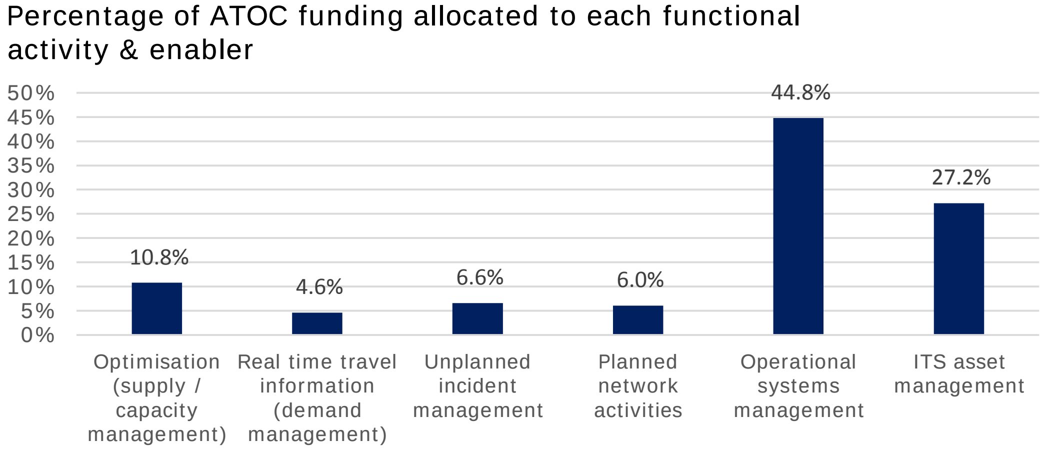
ATOC

The table below shows the dollar spend and percentage of the reforecast FY16/17 ATOC funding request (including both NZTA and Auckland Transport funding) allocated to each functional activity and enabler, while the chart shows the percentage of the total ATOC budget allocated to each functional activity and enabler.

The table shows that the largest portion ($11.1 million, or 44.8%) of ATOC's $24.7 million budget goes towards supporting the operational systems management enabler. This includes a $1.6 million allocation for IT managed services and Dynac support provided by NZTA headquarters. The ITS asset management enabler also accounts for a significant portion ($6.7 million, or 27.2%) of ATOC's budget. The core TOC functional activities account for the remaining 28%. Optimisation comprises 10.8%, while the unplanned incident management and planned network activities functions both comprise a similar percentage (6.6% and 6.0% respectively) of the budget. The real time travel information function accounts for the smallest portion of the budget at 4.6%.

Total ATOC funding by functional activity & enabler

Funding ($m)	Total funding	% of funding
Optimisation (supply / capacity management)	2.66	*10.8%*
Real time travel information (demand manageme	1.14	*4.6%*
Unplanned incident management	1.63	*6.6%*
Planned network activities	1.49	*6.0%*
Operational systems management	11.06	*44.8%*
ITS asset management	6.72	*27.2%*
Total funding	**24.70**	



The cost allocation shown above highlights the significant investment in the enablers, in particular related to maintenance and renewals, and the need to understand the proportion of time these assets are used for each functional activity. The relative proportions of the funding allocated to each functional activity aligns to the purpose and strategy of the TOC; to optimise the network, help customers make informed choices, and to direct traffic in ways that reduce congestion and improve reliability. Unplanned incident management seems high relative to the planned network activities and real time travel information functions, given it is a reactive function. However, incidents are proven to cause significant costs to users and managing these is an important component of providing benefits and reduced costs, as well as improving safety.

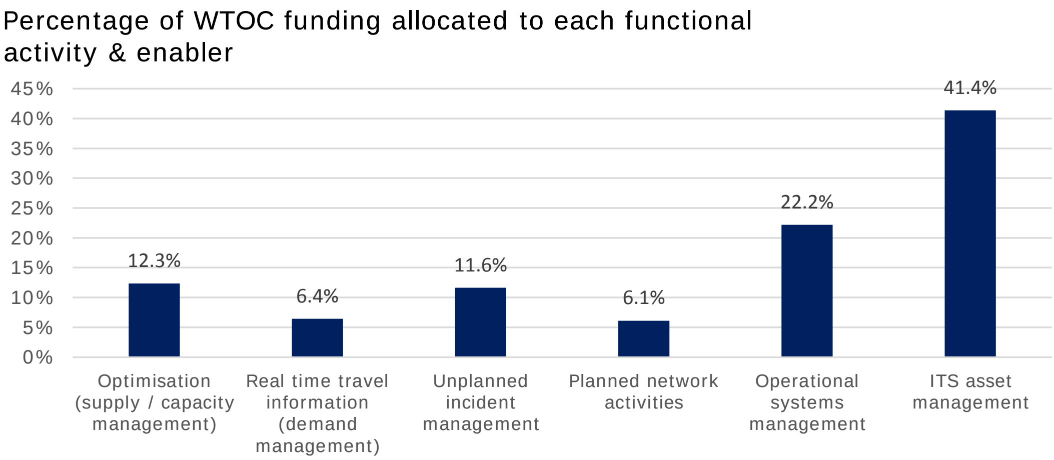
WTOC

The table below shows the dollar spend and percentage of the WTOC FY16/17 funding request allocated to each functional activity and enabler, while the chart shows the percentage of the total WTOC funding request allocated to each functional activity and enabler.

The table shows that the largest portion ($4.1 million, or 41.4%) of WTOC's $9.9 million budget goes towards supporting the ITS asset management enabler. The operational systems management enabler accounts for $2.2 million (22.2%) of the budget, of which $1.6 million relates to IT managed services and Dynac support provided by NZTA headquarters. Optimisation accounts for 12.3% of the budget, followed closely by unplanned incident management with 11.6% of the budget. Real time travel information (6.4%) and planned network activities (6.1%) account for similar proportions of the budget.

Total WTOC funding by functional activity & enabler

Funding ($m)	**Total funding**	**% of funding**
Optimisation (supply / capacity management)	1.23	*12.3%*
Real time travel information (demand manageme	0.64	*6.4%*
Unplanned incident management	1.15	*11.6%*
Planned network activities	0.61	*6.1%*
Operational systems management	2.20	*22.2%*
ITS asset management	4.11	*41.4%*
Total funding	**9.94**	



Unlike ATOC, the ITS asset management enabler accounts for the highest proportion of WTOC's budget. The magnitude of the ITS asset management category is partly explained by a $1.7 million allocation to traffic signal renewals. The nature of these assets means that, in the absence of a maintenance and renewals programme, the expenditure related to these assets can be lumpy. As with ATOC, the proportion allocated to unplanned incident management appears to be high, and the real time travel function appears to be low. However, given the size of WTOC's network, covering significant sections of the country, it seems logical that a large number of incidents would require identification and management.

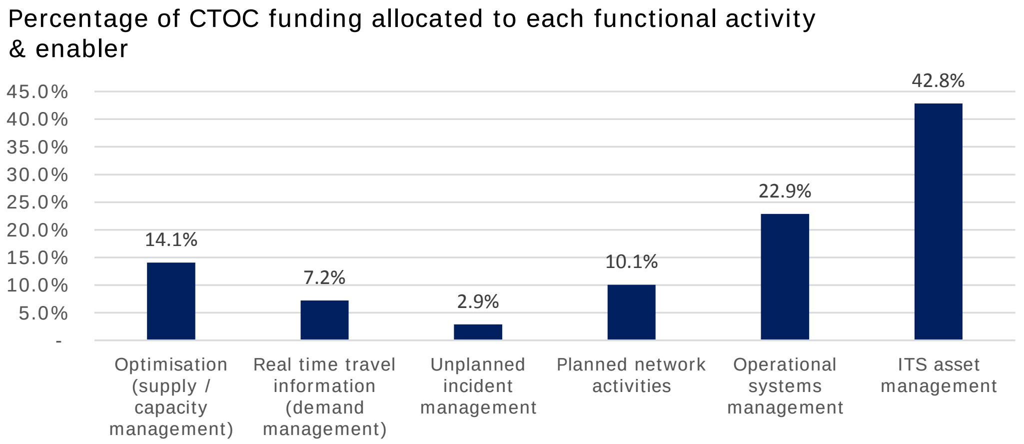
CTOC

The table below shows the dollar spend and percentage of the CTOC FY16/17 funding request (including both NZTA and Christchurch City Council (**CCC**) funding) allocated to each functional activity and enabler, while the chart shows the percentage of the total CTOC funding request allocated to each functional activity and enabler.

The table shows that the largest share ($3.3 million, or 42.8%) of CTOC's $7.8 million budget goes towards supporting the ITS asset management enabler. The $1.6 million allocation for national headquarters-provided IT managed services and Dynac support contributes to an operational systems management budget of $1.8 million (22.9%). The optimisation function accounts for 14.1% of the budget, while planned network activities accounts for 10.1%, reflecting CTOC's strong involvement in event planning with CCC. Unplanned incident management only accounts for 2.9% of the budget.

Total CTOC funding by functional activity & enabler

Funding ($m)	Total funding	% of funding
Optimisation (supply / capacity management)	1.09	*14.1%*
Real time travel information (demand manageme	0.56	*7.2%*
Unplanned incident management	0.23	*2.9%*
Planned network activities	0.78	*10.1%*
Operational systems management	1.78	*22.9%*
ITS asset management	3.33	*42.8%*
Total funding	**7.78**	



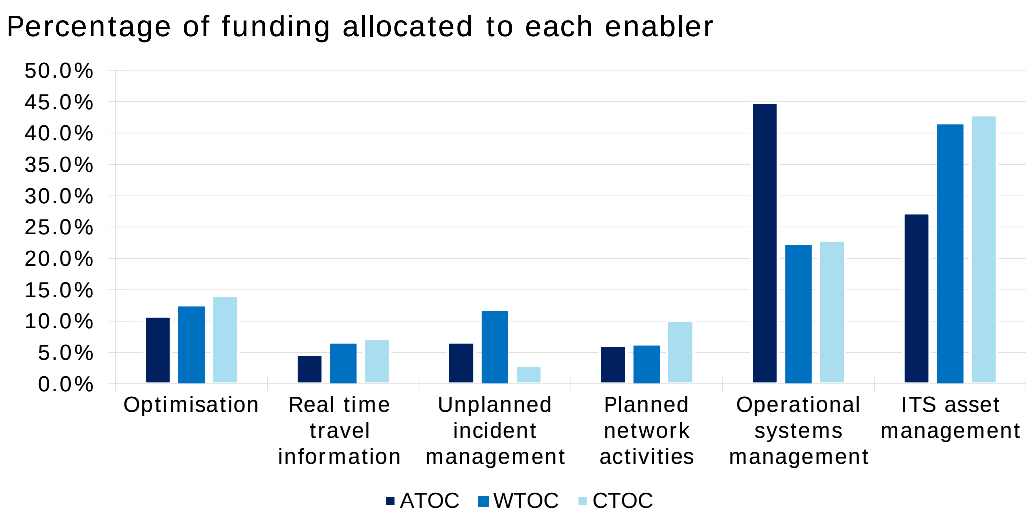
As with WTOC, the maintenance and renewals costs associated with CTOC's ITS asset management enabler results in this enabler accounting for a significant proportion of CTOC's budget. The high proportion of CTOC's budget allocated to planned network activities relative to the other functional activities relates to CTOC's role in approving events that impact on the road network. The allocation of the budget to unplanned incident management seems low, but likely relates to the relatively small area monitored by CTOC.

Overall TOC funding

The table below summarises the funding by TOC allocated to each functional activity and enabler, while the chart below illustrates the proportion of each TOC's total funding allocated to each functional activity and enabler.

Overall funding by functional activity and enabler

Funding ($m)	**ATOC**	**WTOC**	**CTOC**	**Total**	**%**
Optimisation (supply / capacity management)	2.66	1.23	1.09	4.98	*11.7%*
Real time travel information (demand management)	1.14	0.64	0.56	2.34	*5.5%*
Unplanned incident management	1.63	1.15	0.23	3.01	*7.1%*
Planned network activities	1.49	0.61	0.78	2.89	*6.8%*
Operational systems management	11.06	2.20	1.78	15.05	*35.5%*
ITS asset management	6.72	4.11	3.33	14.16	*33.4%*
Total funding	**24.70**	**9.94**	**7.78**	**42.43**	



The differences in funding allocated to each functional activity and enabler is related to the differences in underlying tasks performed by each TOC. However, a full list of tasks for each TOC was not provided, which would have helped explain the different funding splits between TOCs.

The proportion of funding allocated to the real time travel information function for each TOC appears to be low. This function could be cross-subsidised by the planned network activities and unplanned incident management functions, which would inform the information distributed.

The proportion allocated to unplanned incident management appears to be high for WTOC, and low for CTOC. However, given the size of WTOC's network compared to CTOC's, it seems logical that more resource would be allocated to the identification and management of incidents. Additionally, incidents are proven to cause significant costs to users and managing these is an important component of providing benefits and reduced costs, as well as improving safety.

The amount of funding allocated to CTOC's planned network activities function relative to the other TOCs relates to CTOC's role in approving events that impact on the road network.

The table shown above highlights the significant investment in the enablers, in particular related to maintenance and renewals, and the need to understand the proportion of time these assets are used for by each functional activity to allow for the allocation of the enablers to each functional activity.

The allocation of ATOC funding to the operational systems management enabler appears high. ATOC's information systems budget (excluding the $1.6 million allocation for IT managed services and Dynac support provided by national headquarters) totals $7.6 million, of which maintenance and renewals accounts for $4.0 million.

Maintenance and renewals account for $6.2 million (92.3%) of ATOC's ITS asset management enabler. Similarly, traffic signal renewals account for $1.7 million (17.4%) and $1.1 million (14.4%) of total budget for WTOC and CTOC respectively. This highlights the importance of improved planning of maintenance and renewals.

5. Benefits

Overview

The benefits framework considers the benefits generated by the TOCs over the most recent financial year. This may not exactly represent the present value of long run benefits, as some of the benefit categories are likely to vary over time. However, it provides an indication of the magnitude of the benefits generated by the TOCs.

The benefits included in the framework comprise the most significant benefits derived from the TOC operations. The benefits were selected following a process which included:

- a literature review of NZTA reports (including the EEM) and international studies (including Austroads);
- conversations with TOC managers and NZTA staff; and
- conversations with Deloitte Australia.

This process highlighted that benefits were derived from three main categories:

- travel time, congestion and reliability;
- unplanned incident management; and
- planned event management.

The measurable benefits within these categories include:

- travel time cost savings;
- congestion cost savings;
- reliability cost savings;
- emissions cost savings;
- vehicle operating costs (**VOC**) savings; and
- crash cost savings.

A description of each of these benefits, the calculations involved, and the information required for each calculation is detailed below. The premise behind each calculation is that the TOC operations are able to influence the following categories through performing the functional activities.

Benefits descriptions

Base travel time, congestion and reliability savings

The travel time, congestion and reliability benefits are calculated by estimating the total annual cost for the road network under the following two scenarios:

- without the TOCs operating and performing the functional activities; and
- with the TOCs operating and performing the functional activities.

The difference between the costs under the without TOCs and with TOCs scenarios for each of these categories is assumed to be the savings derived from the TOC operations.

The calculation of time saving, congestion and reliability benefits cover the whole network including incident management. There are alternative methodologies of calculating the benefits of incident management, in terms of cost saving per incident or reduction in incident duration due to TOC activities. These are detailed in the benefits worksheets and rely on generic assumptions from the EEM and commissioned studies, including a study of Auckland corridors using Tom Tom data. If the whole network data is not available these methods may be used to calculate the benefits of those activities. If the whole network calculations above are used, the savings of incident management will be assumed to be included in those.

Base travel time savings

This benefit relates to the value travellers place on travel time. The benefits worksheets capture the reduction in the average total travel time due to TOC operations.

Methodology

The average cost related to passenger travel time for each hour of the day is calculated as:

Average hourly travel time cost = average hourly total passenger time on network * base hourly value of time

The average cost for each hour of the day is summed to form an average daily travel time cost. This cost is multiplied by an expansion factor of 345 (from NSW Government, 'Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives') to derive the average annual travel time cost.

The base travel time savings due to the TOC operations is subsequently calculated as the difference between the average annual travel time cost without TOCs and the annual travel time cost with TOCs.

Required Inputs

The EEM details hourly base travel time values by trip purpose, travel time period, and road category. The benefits worksheets use a base value of travel time of $16.27 per passenger hour (in 2002 dollars) that has been inflated to $23.59 per passenger hour using the EEM-stipulated uplift factors. This value relates to the average hourly value placed on travel on the urban arterial network. It has been used as a proxy for the most common type of travel on the TOCs' networks.

The data required to approximate the average passenger time on the road network by hour of the day relies on studies of key arterial routes on the TOC networks. While this data is not readily available, there would be significant benefits from collecting this data over and above its usefulness for this analysis.

Literature on the effectiveness of TOCs (NZTA report 584, 'Considering a Cost-Benefit Analysis Framework for Intelligent Transport Systems', Feb 2016) estimated that the reduction in travel time from TOC activities related to pre-trip information, variable message signs and advanced signal control was in the vicinity of 7% to 60%. However, these studies tended to be for individual projects, and didn't consider the overall time saving for the whole road network.

The framework uses a travel time saving due to TOC activities assumption of 5%, which is less than the low end of the range mentioned above. This reflects the fact that improving travel times on key arterial routes (that are measured by TOC studies) could partially be at the expense of increased travel times on other routes that are not measured by the TOCs. This factor is applied to the travel times under the with TOCs scenario to estimate travel times under the without TOCs scenario. [Additionally, a factor of 1.2 passengers per vehicles has been used to obtain the passenger time on network.]

Congestion savings

The premise behind the benefits associated with congestion is that road users value reductions in congestion over and above the benefits gained from travel time savings.

Methodology

The average cost related to congestion for each hour of the day is calculated as:

Average hourly congestion cost = average hourly total vehicle time spent on segments of the network with VCR exceeding 70% * adjusted hourly maximum increment for congestion

where: average hourly total vehicle time spent on segments of the network with VCR exceeding 70% = average total vehicle time on network * % of time spent on segments exceeding 70% VCR

*adjusted increment for congestion = maximum hourly increment for congestion * (average VCR for parts of the network exceeding 70% – 70% (of road network capacity)) / 30% (of road network capacity))*

As per the travel time savings calculation, the hourly congestion costs are summed to determine the daily cost. The daily congestion cost under each scenario is annualised by the approach described above, and the difference between the total congestion costs without TOCs and the total congestion costs with TOCs is determined to be the congestion savings from the TOC operations.

Required Inputs

The EEM details hourly maximum increment for congestion values for passenger and commercial occupants by trip time period and road category. The benefits worksheets use a maximum increment for congestion of $3.95 per vehicle hour (in 2002 dollars) that has been inflated to $5.73 per vehicle hour using EEM-stipulated uplift factors. This relates to the average hourly increment for congestion on the urban arterial network for all time periods. This value has been used as a proxy for the most common type of travel on the TOC networks.

The data required to approximate the average vehicle time on network by hour of the day relies on studies of key arterial routes on the TOC networks. While this data is not readily available, there would be significant benefits from collecting this data over and above its usefulness for this analysis.

Similarly, studies on the volume-to-capacity ratio (**VCR**) of key arterial routes by hour of the day would provide proxies for the average VCR for parts of the network exceeding 70% VCR, and the percentage of time spent on segments exceeding 70% VCR.

Value of reliability

This benefit relates to the value that road users place on predictable journey times. Trip reliability is defined as the variation in journey times. The impact is related to the day-to-day variations in traffic congestion.

Methodology

The average cost related to trip reliability for each hour of the day is calculated as:

Average hourly reliability cost = standard deviation of passenger time on the network (in hours) * hourly value of reliability

*where: hourly value of reliability = base hourly value of travel time * reliability ratio*

The average cost for each hour of the day is summed to form an average daily cost of reliability. This value is multiplied by the expansion factor to derive the average annual cost of reliability. The difference between the total reliability costs without TOCs and the total reliability cost with TOCs is the reliability benefit derived from the TOC operations.

Required Inputs

The standard deviation of passenger time on the network should be calculated by performing studies on passenger time on the network on key arterial routes by hour of the day. Studies would have to be performed over an extended period to generate a meaningful standard deviation. The required data for this calculation should be available if the passenger data for the base travel time savings calculation is collected.

The reliability ratio used in the workbook is 0.9 times, as stated in the EEM as the value of reliability based on a typical urban mix.

The base hourly value of time is the $23.59 per passenger hour described above.

Vehicle operating costs savings

This benefit measures the reduction in vehicle operating costs (**VOC**) (principally fuel consumption) from TOC activities. The VOC component of the benefits derived from TOC operations relates to the base travel time savings and congestion savings benefits derived above, and includes travel time savings from incident management and planned event management described below.

Methodology

The benefits worksheets calculate annual VOC savings as:

Annual VOC savings = 5.75% * (annual base travel time savings + annual congestion savings)

Required Inputs

The reduction in VOC related to TOC activities was assessed to be in the range of 5.5% to 6.0% of the base travel time and congestion savings in a NZTA research report (NZTA Report 489, 'The Cost of Congestion Reappraised', Feb 2013). The midpoint of this range is used in the benefits worksheets.

The annual base travel time savings and annual congestion savings correspond to the savings calculated above.

Emissions cost savings

Delays to vehicles on the road network from increased congestion, unplanned incidents and planned events results in additional vehicle emissions from detours and delays. TOC activities aim to reduce congestion and the associated emissions costs through improving traffic flow, undertaking event planning, and performing incident detection and management activities.

Methodology

The benefits worksheets calculate the average daily value of reduced vehicle emissions as:

Average daily emissions cost savings = 0.18 * (average daily vehicle time on the road network without TOCs – average daily vehicle time on the road network with TOCs)

The daily cost savings are multiplied by the expansion factor mentioned above to derive the annual emissions cost savings from the TOC operations.

Required Inputs

A NZTA research report (NZTA Report 570, 'Travel Time Saving Assessment', Apr 2015) estimated vehicle emissions at $0.16 per vehicle hour. This has been inflated using a pro-rata amount of the July 2008 uplift factor as outlined in EEM guidance to $0.18 per vehicle hour.

The average daily vehicle time on the road network should be measured for the assessment of the congestion cost savings outlined above.

Incident-related secondary crash cost savings

Incident detection and management programmes have been noted to reduce the number of follow-on crashes related to unplanned incidents through liaising with emergency services to respond to incidents, directing contractors to clear affected roads, and informing travellers of crashes and alternate routes.

Methodology

The benefits worksheets calculate the annual savings related to reduced incident-related secondary crashes as:

Annual incident-related secondary crash savings = (annual number of incident-related secondary crashes without TOCs – annual number of incident-related secondary crashes with TOCs) * 29,551

where: annual number of incident-related secondary crashes without TOCs = annual number of incident-related crashes with TOCs / (1 – 40%)

Required Inputs

A NZTA research report (NZTA report 584, 'Considering a Cost-Benefit Analysis Framework for Intelligent Transport Systems', Feb 2016) stated that incident detection and management could reduce the number of secondary rear-end crashes by 40%.

The number of incident-related secondary crashes should be recorded by the TOCs.

The $29,551 assumption corresponds to the inflated EEM average cost of a minor crash.

Major crashes have much higher costs attached to them. CTOC assessed the cost of incidents as being in the range of $40,000 to $80,000 per incident. The EEM lists crash costs of up to c. $4m for a fatal crash. Based on the number of incidents per annum, there is a significant opportunity for the TOCs to reduce incident related costs through preventing incidents. This will reduce costs associated with incident duration, other incident related costs and incident-related crashes. Other incident related costs could be applied to the assumed reduction in incident numbers through TOC activities to calculate additional incident management savings.

Planned event-related crash cost savings

TOCs have the ability to reduce the number of crashes related to planned events through liaising with event organisers and local councils, and planning the road network to effectively and efficiently deal with the increased capacity related to these events. A component of this is the cost of crashes that occur due to these events.

Methodology

The benefits worksheets calculate the annual savings related to reduced planned event-related crashes as:

Annual planned event-related crash savings = (annual number of planned event-related crashes without TOCs – annual number of planned event-related crashes with TOCs) * 29,551

where: annual number of planned event-related crashes without TOCs = annual number of planned event-related crashes with TOCs / (1 – 40%)

Required Inputs

The benefits worksheets currently use the reduction in the number of secondary rear-end crashes assumption of 40% as a proxy to estimate the reduction in planned event-related crashes. However, the TOCs should measure the number of event-related crashes to understand the change in event-related crashes due to TOC operations.

The number of planned event-related crashes should be recorded by the TOCs.

The $29,551 assumption corresponds to the inflated EEM average cost of a minor crash.

Other measures

Additional calculations that measure the benefits related to unplanned incidents and planned network events are shown in the benefits worksheets. These additional measures are generally used to assess the benefits related to projects. The values from these measures are not accounted for in the total benefits as the network-wide measures used pick up these benefits.

The benefit calculations include:

- incident-related time, emissions and VOC savings; and
- planned event-related time, emissions and VOC savings.

Furthermore, there is evidence from the commissioned studies reviewed of average benefit-cost ratios and percentage reduction in congestion, fatal crashes and other measures due to TOC activities. These statistics may be useful in describing and quantifying the benefits of traffic management activities in the NZTA business case.

6. Benefit-cost ratios

Total benefits

The table below outlines the savings / benefit associated with each benefit category derived from the TOC operations. As mentioned in previous sections, this analysis provides BCRs for each TOC based on a single year view, rather than considering the NPV over a longer period of time.

Total TOC Benefits

Savings ($m)	ATOC	WTOC	CTOC
Travel time savings	118.66	33.00	60.67
Reliability savings	-	-	-
Congestion cost savings	-	-	-
Vehicle operating costs savings	6.82	1.90	3.49
Crash cost savings	-	-	-
Emissions cost savings	0.76	0.21	0.39
Total TOC benefits	**126.24**	**35.11**	**64.54**

Total costs

The table below outlines the total funding allocated to each functional activity and enabler for each of the TOCs.

Overall funding by functional activity and enabler

Funding ($m)	ATOC	WTOC	CTOC
Optimisation (supply / capacity management)	2.66	1.23	1.09
Real time travel information (demand management)	1.14	0.64	0.56
Unplanned incident management	1.63	1.15	0.23
Planned network activities	1.49	0.61	0.78
Operational systems management	11.06	2.20	1.78
ITS asset management	6.72	4.11	3.33
Total funding	**24.70**	**9.94**	**7.78**

Overall BCR

The BCR analysis was limited by the lack of availability of the required network data. Limited information was provided for measuring the travel time benefits associated with the TOCs. Travel time data was provided for each of the TOCs based on studies performed on key network routes during 2016. This data was limited by the number of routes analysed by each TOC; with the CTOC study (22 roads measured) being significantly more comprehensive than the ATOC (seven roads) and WTOC (three roads) studies. However, this network data was used in the workbooks to provide an indication of the magnitude of the BCR ratios for each of the TOCs, notwithstanding that including more reliable travel time data, and network data for the congestion and reliability benefits would increase the ratios for each TOC.

The VOC and emissions cost savings benefit calculations use inputs from the travel time savings benefit calculation. The VOC and emissions cost savings related to travel time savings are therefore included within each of the BCRs listed above.

Incident data was provided by CTOC, however, it was difficult to distinguish between initial incidents and secondary crashes related to incidents. Therefore, this section of the workbook was left empty, and a recommendation has been included in Section 8 to classify all incidents in a manner that would allow this type of incident to be readily identified for this analysis.

The analysis performed using the travel time information mentioned above indicated CTOC had the highest BCR at **8.3**, followed by ATOC (**5.1**) and WTOC (**3.5**). These are shown in the table below. The ratios were likely distorted by the number of studies performed on each network as the total number of vehicles on the road network (being a significant contributor to the output of this calculation) would likely be understated in Wellington and Auckland. However, the ratios provide an indication of the likely level of benefit provided by the TOCs' operations.

Total TOC benefit-cost ratio

	ATOC	WTOC	CTOC
Total benefits	126.24	35.11	64.54
Total costs	24.70	9.94	7.78
Benefit-cost ratio	**5.11**	**3.53**	**8.30**

Observed BCRs from commissioned studies

NZTA and overseas transport authorities have commissioned various studies to analyse the BCR of transport network management activities. These have studied the impact of network management activities such as incident management, optimisation and real time communication on factors such as congestion, secondary crashes and reliability.

The EEM has estimated crash costs at between $28,000 for a minor crash to $4.7 million for a fatal crash. A NZTA report (NZTA report 584, 'Considering a Cost-Benefit Analysis Framework for Intelligent Framework Systems', Feb 2016) performed a study in Europe on integrated traveller information systems and found that they could reduce crashes by 2-3%. This obviously provides significant benefits depending on the crash rate and the number of major or fatal crashes prevented. The TOCs do perform services akin to the traveller information systems studied in Europe. This indicates the potential magnitude for benefits and BCR values. These aren't quantified in New Zealand as there hasn't been a study performed on the TOCs' impact on crashes other than Report 594's ('Demonstrating the benefit of network operations activities', Jun 2016) study on the duration of Auckland incidents and CTOC's estimate of incident-related delay and savings experienced.

International literature reviewed in Report 594 indicated BCR results for various network operations including networking monitoring, real-time operations, travel information, and temporary traffic management, of at least **4.0**, with some indicating results of higher than **10.0**.

A study of an incident management system (in Report 594) implemented on Auckland's North Shore that uses traveller information and intelligence monitoring to develop alternative routes during incidents estimated a BCR of between **7.0** and **8.0** for this system.

A CTOC study that tested the impact of signal optimisation on key arterial routes found BCR ratios of greater than **10.0**. One particular study on signal optimisation at the intersection of Blenheim and Curletts Roads estimated a BCR of **65.0**. Another study by CTOC on the impact of traveller information and incident response management on congestion estimated that these activities generated a BCR of greater than **10.0**.

It is worth noting that the BCR values tended to be for individual schemes, however the indicated high BCR values for these schemes imply that the combination of the TOC functional activities would likely derive a high BCR value.

Typically, there were high values for transport management activities. The cost of congestion, variable trip times and crashes is significant to road users and the public sector. Management activities such as incident management reducing congestion and related crashes, real time information or optimisation reducing congestion, crashes and improving reliability are found to have a high benefit when quantified.

7. Other considerations

TOC considerations

During the interview process with the TOC managers, it was identified that certain aspects of the TOC operations would not be visible as a result of this framework. The following subsections outline the concerns that were highlighted during the interview process.

Impacts of materially reduced funding / risks

A list of the likely impacts of a material reduction in TOC funding includes:

- limited co-ordination of road works;
- incident response times would be significant and full road closures common;
- limited travel time or real time travel information;
- traffic signals monitoring and optimisation would be limited;
- local authorities would act independent of any national transport strategy; and
- events such as the Kaikoura and Canterbury earthquakes would have delayed, rather than real time, responses.

Budget constraints

Specific funding constraints that were highlighted by the TOCs include:

WTOC

- Funding has not previously been available to install fibre and CCTV cameras at certain network hotspots;
- maintenance and renewals have previously not been budgeted as part of a maintenance and renewals plan. The manager suggested that an ITS programme management and data capture system would provide greater clarity around required maintenance and renewals, and reduce reactive ITS asset management; and
- the control room located at WTOC is currently at capacity which has a direct impact on performance.

Business case considerations

The business case will consider the potential costs and benefits of the TOC operations, potentially looking at various options including revising the scope of the TOCs, changing the funding amount or structure, and changing the services they perform.

Business cases focus on three factors to determine the preferred way forward in an economic case. These factors are:

- economic value (net present value or BCR analysis);
- non-monetary benefits; and,
- risks.

While we have attempted to allocate costs appropriately to each of the functional activities and enablers, this is different from estimating the marginal cost of adding a new functional activity to an existing TOC operation as this could be significantly less than the allocated cost. For example, if the TOCs are required to manage major incidents, then the marginal cost of adding additional activities may be quite low relative to the benefits. This is important to keep in mind when considering the potential BCRs of individual activities.

Additionally, while the TOCs may provide BCR values based on the methodologies described above, and these may be analysed in terms of tasks and activities for each TOC, it is important to consider other benefits, risks and strategic objectives of NZTA.

Achieving monetary benefits may be important, but other factors will also impact on the level of funding allocated to TOCs and the BCR value that is accepted as reasonable. These may include:

- safety (potential for increased accidents, injuries and fatalities without the TOCs);
- road user satisfaction, potential for reputational damage and dissatisfaction by users of the network;
- NZTA priorities including reducing congestion and passenger hours for a more liveable city, or reduced emissions to reduce the impact on the environment;
- risk of catastrophic impact through reduced funding or scope; for example, are system maintenance and inspections required to prevent a whole system failure which may impact all traffic signals and lead to significant disbenefits for the network;
- other strategic priorities for NZTA and the NZ government aligning to TOC activities; and
- risks mitigated or reduced through TOC activities or risks assumed through the current level of services provided (i.e. further work / resource required to mitigate significant risks).

8. Recommendations

Allocating resource to analyse TOC functional activities and benefit data

Much of the data required to calculate the impact (benefit) of TOC functional activities, as well as which functional activities TOC staff are spending their time on, was either not available, or would have required a significant time investment to extract. For example, information requested from ATOC on the number of incidents during the year, incidents by type, and typical travel time, delays and vehicle numbers was not available in a format that could readily be accessed. Data is either not recorded by ATOC, or the TOC did not have the required level of resource to gather this data from its systems.

If NZTA wants to have a detailed analysis of TOC functional activities and the measurable benefits from this, it may need to invest in systems which capture and store data such as the number of vehicles on the network, number of incidents, incident duration, and/or invest in resources to study and collect this data from what is available. An additional resource may be able to pull out this data from the existing systems and populate the benefits calculations. The following recommendation outlines the specific information that was not provided to us during this process due to resource limitations to extract the information, or because the data was not recorded.

Recording network information

The quantification of some of the benefits related to the TOC operations was limited by the availability of certain network data.

Some of the travel time and incident / event data is measured at a micro-level at some of the TOCs, with particularly good information available from CTOC on key routes. This data could be used to extrapolate to the network-wide level (noting that CTOC is responsible for the smallest and most urban network), or to provide indicative information on average delays, incident durations, and the performance of the TOC and network on reducing journey times and predictability over time. However, recording, documenting and monitoring data, including data from Google, TomTom and TOC information systems on certain corridors and routes is important for understanding the impacts of TOCs and the key drivers of TOC activities and costs.

The data that is currently not available but is required to quantify the benefits of the TOC operations in the workbooks for each TOC (and the primary benefit to which the data relates) includes:

- average passenger time on the road network by hour of the day (**base travel time savings**);
- average vehicle time on the road network by hour of the day (**congestion savings**);
- % of travel time spent on segments exceeding 70% VCR (**congestion savings**);
- average VCR for parts of network exceeding 70% (**congestion savings**);
- standard deviation of passenger time by hour of the day (**value of reliability**);
- annual number of event-related crashes (**crash cost savings**); and
- annual number of incident-related secondary crashes (**crash cost savings**).

Maintenance and renewals planning

It was noted by the TOC managers that a relatively large portion of renewals and maintenance spend related to ITS infrastructure and software systems is unplanned. This reflects the large and complex nature of the assets that the TOCs are managing.

It would be worthwhile developing a renewals and maintenance plan for ITS infrastructure for each of the TOCs to minimise the risk of faults from these assets. While the nature of these assets means that certain faults cannot be avoided, a renewals and maintenance plan would minimise the likelihood of outages, and make the costs incurred related to these assets more predictable and easier to budget for.

Funding forecasts

The funding requests developed by the TOCs and submitted to NZTA are for the next ten financial years. However, the level of reliability for the years beyond the first financial year in the forecasts is questionable.

For example, the CTOC funding request to NZTA (solely for NZTA, and not CCC, funding) had a total funding request for the 2016/17 financial year of $3.7 million. The forecast funding request total for the next four financial years totalled $3.5 million, $3.0 million, $2.6 million, and $2.5 million respectively. The traffic signals renewals ($0.6 million decline) and surveillance / CCTV renewals ($0.1 million decline) categories accounted for $0.7 million of the decrease over this period. These decreases relate to the reactive nature of TOC maintenance and renewals, and align with the recommendation above regarding maintenance and renewals planning.

Another key contributor to the decrease is a $0.2 million decline in traffic operations accommodation and operations to $140,000; while the remaining non-maintenance and renewals categories increase by small increments each year. The decrease in traffic operations accommodation and operations funding doesn't appear to have much basis, as the demand for TOC activities is unlikely to decrease unless there is a decline in the use of the road network.

It would be beneficial for the TOCs to provide funding requests for five or ten year periods that incorporate the funding required from the maintenance and renewals planning. Additionally, the remaining categories should be escalated based on some form of proxy for the anticipated increase in demand for the TOC activities (e.g. vehicle kilometres travelled), to provide more realistic forecasts of the funding required by the TOCs. Adopting this forward-looking approach would allow the TOCs to identify future pressure points, and would also provide context for investment in future technologies, and the impact that these technologies could have on other costs.

The average annual funding request total for the forecast period should be used in the cost and benefits workbook to provide a more realistic view of the average funding required to run the TOCs. This will avoid lumpy expenditure such as traffic signal renewals having a significant impact on the resulting BCRs for the TOCs.

Consistent IT systems

It is understood from discussions with the TOC managers that each of the TOCs use a large number of different IT systems and processes, which are not necessarily consistent across the TOCs. This means the TOCs cannot easily share information and do not necessarily receive or record the same information in the same format. This may be exacerbated by each TOC having a different ownership structure.

Additionally, the use of different IT systems would likely mean that there is an opportunity to reduce IT costs across the TOCs by using the same systems where possible. This would involve understanding which systems are used within each TOC to identify which systems are used consistently across the TOCs or have functions that are included within other systems, to allow for efficiencies through centrally purchased technologies.

It would be beneficial to perform a review of the IT systems and technologies used across the TOCs. This may result in better IT systems which are consistent across TOCs and 'talk to each other' – allowing better data sharing and reporting. It may also provide efficiencies if contracts for system upgrades or renewals are negotiated together.

Timesheets for TOC employees

The TOCs were unclear about how much of their time and resources was spent on each functional activity or the tasks included within them. The TOC employees generally work across the functional activities as and when needed.

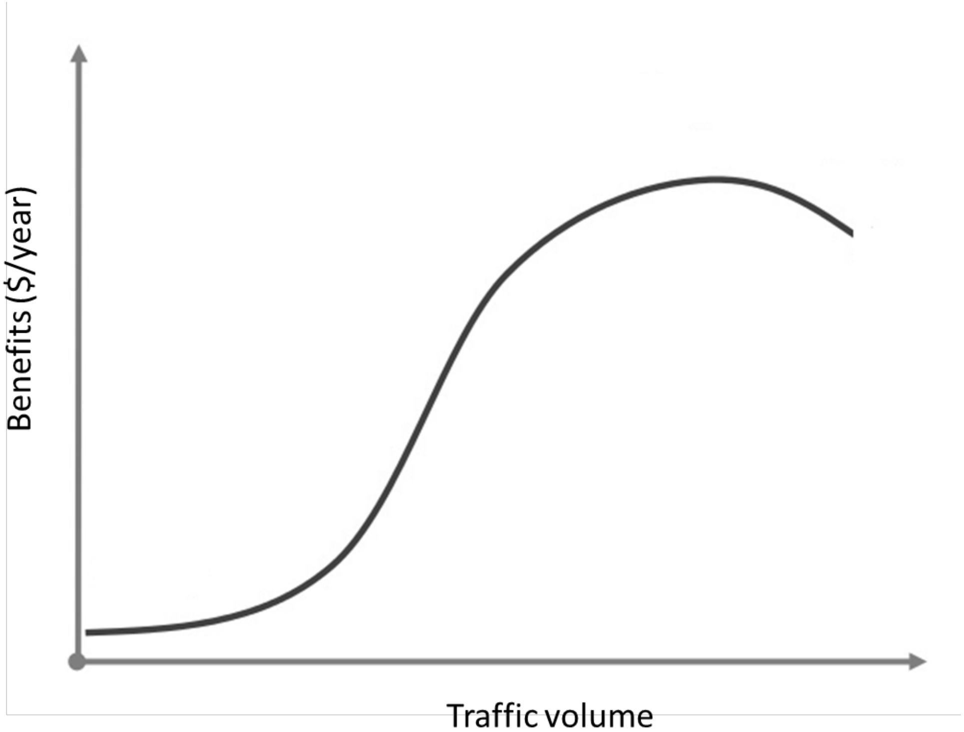
In order to understand which functional activities and tasks require the most employee time, and where systems or processes are slowing down operations, it may be useful for the TOCs to implement timesheets or, at minimum, undertake some analysis on how many hours in each day staff are spending on various tasks and functional activities. An alternative to implementing timesheets would be to ask staff to record which tasks they performed and the amount of time spent on each over a set period of time. This would give a more robust analysis of the cost allocation to functional activities, as well as highlighting tasks which take a large amount of time – potentially indicating areas where systems or processes may be able to be used to improve efficiency or where more staff are needed. This may also help management in understanding the TOC operations and how it allocates staff and resources. This could be monitored on an ongoing basis to understand trends in traffic incidents and TOC activities, impacts on the TOC and traffic network of changing resources, and the impacts on TOCs of events, seasons or changes in external factors on the TOCs.

Additionally, given the size of the TOCs' investment in the operational systems management and ITS asset management enablers, an allocation of the costs associated with these enablers based on the proportion of time the underlying systems are used to support each functional activity would provide a more accurate view of the cost of each functional activity. This information could be captured through the use of timesheets or the study mentioned above.

9. Next steps

The tool we have developed is targeted at providing an estimation of the current benefits of an operating TOC in order to identify the benefits that society is getting from its investment in the TOC. The model is not perfectly suited to answering questions about when to alter the structure of a TOC but it can provide some information.

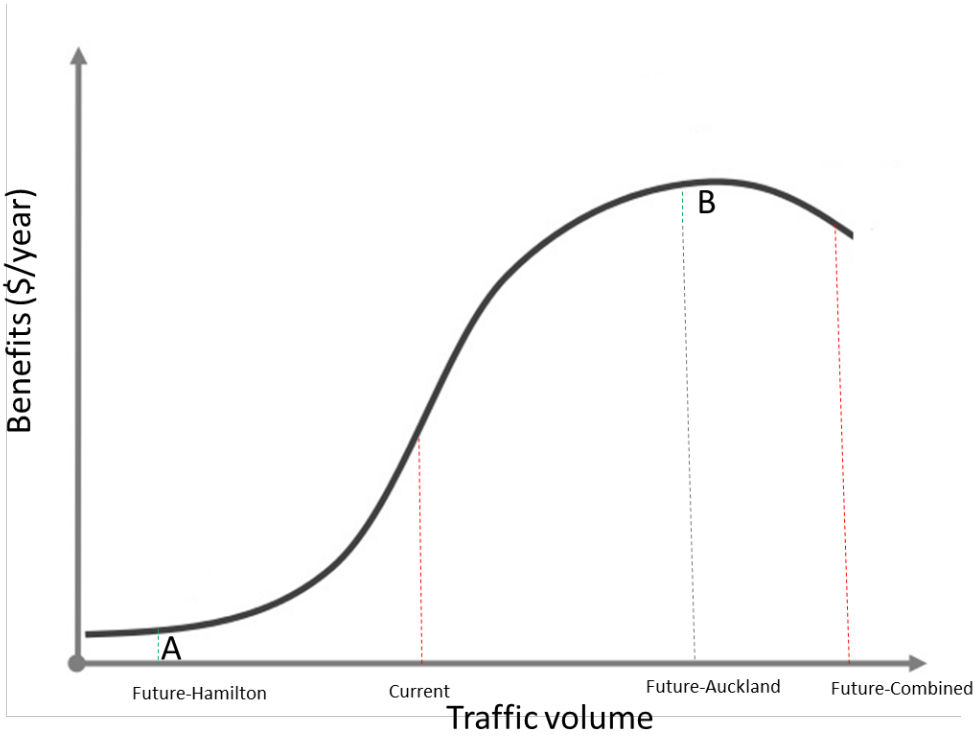
Conceptually, the likely relationship between traffic volumes and the benefits generated by a TOC is shown in the chart below. For small increases in traffic volumes a TOC is likely to see increasing benefits, this is because more traffic means more chances of incidents and congestion that can be managed by the TOC. At some point, the size of the network or volume of traffic will become too large and the benefits of the TOC will either flat line or begin to decline. This is because the number of incidents that the TOC can manage or respond to will be capped at some number. A decline could occur because, as the network becomes more complex, the priority incidents may require a greater amount of time or effort to manage and so may crowd-out lesser priority incidents.



If, over time, it was perceived that the traffic volume was growing to a level that could not be managed within the existing TOC then it may become beneficial to either expand the TOC or establish a new TOC. Establishing a new TOC would be beneficial where localised knowledge or specialisation are particularly important for efficient response to incidents. Establishing a new TOC would have associated costs of IT systems, management and the like. The chart below shows the type of benefits that would be generated from establishing a new TOC. In the diagram the Future combined TOC is on the downward sloping part of the benefits relationship. By splitting up the TOC, the Auckland TOC can focus on a smaller network and generate more benefits while the Hamilton TOC can generate modest benefits on its small network.

The benefits of providing a new TOC is to reduce the expected decline in TOC performance as the network increases. There will be no economic benefits of a new TOC if the existing TOC could easily handle the volume of work required.

The practical question for decision makers is then whether the present value of benefits (green line segments A and B added together, incurred each year and discounted to present values) outweigh the present value of costs of establishing the new TOC. The model we have provided can be used to estimate the level of benefits generated by a TOC in a single year costs in a single year. This information can inform decisions about expanding TOC coverage but cannot address it directly.



A limitation is that our model requires inputs on network performance (such as VCR in excess of 70% and standard deviations of travel time). For a fixed set of this network information, our model will estimate that if there is more traffic the TOC will deliver greater benefits. This does not capture the relationship identified above whereby benefits could start to decline.

Over time, however, if the information in the model is completed each year, then the network information will change each year and the estimated benefits of the TOC will change depending on network performance. These trends over time will provide a strong indication of long term changes in performance of the network and may indicate when performance begins to deteriorate at an unacceptable rate. The measures that should change year to year and should be tracked include:

- average total travel time on network;
- standard deviation of travel time;
- percentage of travel time spent in conditions with VCR >70%;
- number of incidents; and
- average delay per incident.

By tracking these trends over time, it may be possible to identify where a TOC is beginning to reach its capacity and hence may require further investment, expansion or splitting into multiple regional organisations.

Appendix A: Sources of information

- NSW Government (Transport for NSW), ‘Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives’, Mar 2013
- NZTA, ‘Economic Evaluation Model’, Jan 2016
- NZTA Report 594, ‘Demonstrating the benefit of network operations activities’, Jun 2016
- NZTA report 489, ‘The Cost of Congestion Reappraised’, Feb 2013
- NZTA report 570, ‘Travel Time Saving Assessment’, Apr 2015
- NZTA report 584, ‘Considering a Cost-Benefit Analysis Framework for Intelligent Framework Systems’, Feb 2016
- Austroads, ‘Congestion & Reliability Review’, Feb 2016
- Conversations with TOC managers
- Conversations with NZTA staff

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We reserve the right to review all calculations included or referred to in this report and, if we consider it necessary, to revise our analysis in the light of any information which becomes known to us after the date of this report.

Reliance on information

In preparing this analysis we have relied upon and assumed, without independent verification, the accuracy and completeness of all information that is available from public sources and all information that was furnished to us by NZTA.

We have evaluated that information through analysis, enquiry and examination for the purposes of preparing this report. However, we have not verified the accuracy or completeness of any such information nor conducted an appraisal of any assets. We have not carried out any form of due diligence or audit on the accounting or other records of NZTA or any businesses covered in this report. We do not warrant that our enquiries have identified or revealed any matter which an audit, due diligence review or extensive examination might disclose.

Disclaimer

This report has been prepared with care and diligence and the statements and conclusions in this report are given in good faith and in the belief, on reasonable grounds, that such statements and conclusions are not false or misleading.

We cannot guarantee that any forecasts of future profits, cash flows or financial position of NZTA or any of the businesses covered in this report will be achieved. Forecasts are inherently uncertain. They are predictions of future events which cannot be assured. They are based upon assumptions, many of which are beyond the control of NZTA or the other businesses and the respective Management teams. Actual results will vary from the forecasts and these variations may be significantly more or less favourable.

Indemnity

We assume no responsibility arising in any way whatsoever for errors or omissions (including responsibility to any person for negligence) for the preparation of this report to the extent that such errors or omissions result from the reasonable reliance on information provided by others or assumptions disclosed in this report or assumptions reasonably taken as implicit.

NZTA has agreed that to the extent permitted by law, it will indemnify Deloitte and its partners, employees and consultants in respect of any liability suffered or incurred as a result of or in connection with the preparation of this report. This indemnity will not apply in respect of any negligence, wilful misconduct or breach of law. NZTA has also agreed to indemnify Deloitte and its partners, employees and consultants for time incurred and any costs in relation to any inquiry or proceeding initiated by any person. Where Deloitte or its partners, employees and consultants are found liable for or guilty of negligence, wilful misconduct or breach of law, Deloitte shall reimburse such costs.