Expanding the Potential of SmartRoads to Improve Road Network Performance

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INTRODUCTION

This report presents the findings of a research project, which examines the potential of SmartRoads, a network operations planning (NOP) framework developed by VicRoads, to improve road traffic network performance. The project is a collaboration between the Monash University Faculty of Engineering’s Institute of Transport Studies and Monash Business School’s Department of Management. It was funded through the support of Monash Infrastructure.

The report aims to document the implementation of SmartRoads in Victoria, including the factors that facilitated or constrained the implementation. It does this by analysing a set of stakeholder interviews and subsequent case study analysis, providing an overview of the implementation of SmartRoads over time, and identifying the benefits of the implementation of SmartRoads, the constraints of SmartRoads and the future of SmartRoads. In doing so, the report provides its audience with an understanding of how SmartRoads may become more efficient and effective for better planning and management of the road traffic network in Victoria.

While the report is based on research conducted in Victoria, the implications of the findings are relevant to other jurisdictions, which currently have NOP frameworks similar to SmartRoads in place or those in which NOP frameworks may be implemented in the future.

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PART 1 BACKGROUND

1 ROAD TRAFFIC NETWORK MANAGEMENT IN VICTORIA

Melbourne has experienced rapid growth, with different modes of transport competing for limited road space. In response to this growth, Transport for Victoria (TFV) was formed in April, 2017, as a statutory authority within the Department of Economic Development, Jobs, and Transport. TFV realises the principal objectives of the Transport Integration Act 2010 (TIA), and thus is responsible for the planning and coordination of all transport systems in Victoria. It acts as an umbrella agency for Public Transport Victoria (the statutory authority that manages all public transport in Victoria, including trains, trams and buses) and VicRoads (the statutory authority that manages Victoria's roads).

Figure 1 illustrates the key stakeholders of the road traffic network in Victoria, which is managed by TFV. These stakeholders range from government bodies, to public transport providers, to municipal councils.

The Transport Integration Act is the prime transport statute in Victoria, as it establishes and sets the charters of the state agencies charged with integrating and coordinating the state’s transport system and, as part of that activity, providing roads, managing network access and providing registration and licensing services.

Since VicRoads is the statutory authority that manages Victoria's roads, it is responsible for upholding the Transport Integration Act through the planning and management of the road traffic network in Victoria.

Table 1 provides lists the organisations that are responsible for each type of road in Victoria.
As indicated in Table 1, VicRoads is responsible for freeways (except those which are privately operated), urban and some non-urban arterial roads, and some none-arterial state roads.

### Table 1: Road Types and Responsible Road Authorities in Victoria

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Coordinating Road Authority</th>
<th>Responsible Road Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway (except privately operated)</td>
<td>VicRoads</td>
<td>VicRoads</td>
</tr>
<tr>
<td>Freeway (privately operated)</td>
<td>Varies</td>
<td>Melbourne CityLink - Transurban</td>
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<td></td>
<td></td>
<td>Eastlink - ConnectEast</td>
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<td></td>
<td></td>
<td>Peninsula Link - Southern Way</td>
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<tr>
<td>Arterial (urban)</td>
<td>VicRoads</td>
<td>VicRoads (through traffic)</td>
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<tr>
<td></td>
<td></td>
<td>Council (service roads, pathways, roadside)</td>
</tr>
<tr>
<td>Arterial (non-urban)</td>
<td>VicRoads</td>
<td>VicRoads</td>
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<td>Council (service roads, pathways)</td>
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<td>Non-arterial (urban)</td>
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<td>Non-arterial (non-urban)</td>
<td>eg. DELWP, Parks Victoria</td>
<td>eg. DELWP, Parks Victoria</td>
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<td></td>
<td>(VicRoads for small number of these roads)</td>
<td>(VicRoads for small number of these roads)</td>
</tr>
</tbody>
</table>

As indicated in Table 1, VicRoads is responsible for freeways (except those which are privately operated), urban and some non-urban arterial roads, and some none-arterial state roads.

## 2 WHAT IS SMARTROADS?

Traffic networks in cities are becoming increasingly complex to manage with multiple transport modes (cars, buses, trucks, cyclists, and pedestrians) competing for limited road space. The use of Network Operations Planning (NOP) frameworks is becoming 'best practice' in managing complex, multi-modal transport networks.

SmartRoads is an example of a network operations planning framework. It provides guidance as to how individual NOP frameworks should be structured. The SmartRoads framework, developed by VicRoads, is used to explicitly manage the trade-offs between modes, integrating community and stakeholder input and measuring expected outcomes in the road network.

SmartRoads was developed in Victoria and evolved out of the increasing complexity of balancing a range of modes (including trams), especially in busy activity centres. However, with the increased recognition of the need to manage road traffic networks with network operating plans, places other than Victoria, e.g., New Zealand and Ipswich (QLD), have also begun to implement the SmartRoads framework.

SmartRoads relies on the Road Use Hierarchy (RUH), which is defined as “The set of guiding principles that allocates priority road use by transport mode. These principles are being used to determine the priority use of arterial roads in Victoria.” The purpose of the RUH is to guide planners about the function of the road. Most roads are not wide enough to allow for all modes to have priority, so this is why a hierarchy is needed. For example, on Sydney Road in Melbourne, there are trams, cars, bicycles, pedestrians and a need for car parking for the traders along the route. The RUH is defined by mapping the road user priorities on maps for municipal council areas.

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Figure 2 shows the VicRoads SmartRoads RUH map for the road traffic network in the City of Boroondara.
EXPANDING THE POTENTIAL OF SMARTROADS TO IMPROVE ROAD NETWORK PERFORMANCE
Since SmartRoads is based on this set of principles, the RUH, the priorities assigned to various modes and the route classifications in the RUH for each jurisdiction need to be agreed upon.

Once roads have been classified using a RUH, needs can be identified based on the current performance of the road network. This performance is assessed using a multimodal Level of Service (LOS) framework.

A software program called the Network Fit Assessment (NFA) is then used to assign an LOS rating to every segment in the RUH, weighted by the volume of vehicles or pedestrians. The outcome of the scoring is a numerical result that describes the weighted shortfall of the road with respect to the ideal and desired operational levels.

The NFA software can then be used in scenario planning, where various changes to road operation can be proposed and their impacts on the network can be assessed.

VicRoads is the principal user of the SmartRoads program, with input and consultation from TFV, public transport operators, local councils and other groups. Some consultancies and public transport operators (particularly Yarra Trams) have taken a more active role in creating and modifying SmartRoads within their jurisdictions.

### 2.1 Where SmartRoads fits into the project lifecycle

SmartRoads is used in two ways: as part of the lifecycle of major projects or as part of minor route reviews.

For significant projects, VicRoads’ project plans are presented in the form of a business case identifying the proposed scope of the works. VicRoads examines this and identifies the risks, opportunities and gaps and then discusses these via high-level engagement with transport industry bodies, councils and other stakeholders. The project is then submitted to the Treasury department for funding, and then submitted back to planning. This is the pre-construction phase of the project. However, before the next phase, depending on the complexity of the project, there is a planning component, which is put together and disseminated either as a business case or pre-construction phase, but this depends on how VicRoads structures the project and the speed at which the project needs to be developed. Figure 3 presents the usual phases of the VicRoads project lifecycle. SmartRoads comes into this process at the start when building the business case and then its application continues when VicRoads makes design changes and conducts route reviews, etc.
More recently, SmartRoads has also been applied in route reviews, which are workshops hosted by VicRoads to assess the efficiency of specific traffic routes. The reviews took place with the participation of various stakeholders who are impacted by the particular route. Route reviews may lead to changes in traffic signals (e.g., phasings, increasing cycle lengths, lagging or leading optimisation etc.) that provide network improvements. However, the reviews may identify the need to make further improvements that require works (e.g., additional lane on road, traffic light installation).

3 THE RESEARCH PROBLEM

VicRoads has been using the SmartRoads framework for several years and it is being adopted in other Australian jurisdictions, in some areas of New Zealand and in 2016 it was codified into national practice through the Austroads “Guide to Traffic Management Part 4: Network Management”3.

However, consultation with VicRoads reveals that some barriers slowed the effectiveness and implementation of SmartRoads. These include:

- A lack of buy-in from local governments and traffic engineers;
- Reactive, operations-focused planning and implementation;
- Limited resourcing available to document the impacts of NOP frameworks (positive or negative);
- Limited ability to explore how NOP frameworks may be applied to other jurisdictions.

Some of these barriers continue to affect the implementation of SmartRoads. Understanding these barriers and their implications should improve the continued use of SmartRoads in Victoria. This may also provide ‘lessons learned’ for other road authorities who are implanting or considering implementing SmartRoads-based network operation planning.

4 AIMS OF THE PROJECT

The aims of the research project are to:

- Examine how SmartRoads has evolved and been implemented in Victoria;
- Examine how SmartRoads assists VicRoads in fulfilling its objectives in line with the Transport Integration Act;
- Identify the factors that facilitate the implementation of SmartRoads;
- Identify the barriers that constrain the implementation of SmartRoads.

The significance of this research project stems from the above issues, with the potential to benefit from formally assessing and developing NOP frameworks. Cities in both developed and developing countries are struggling to manage traffic growth, balancing the needs of different modes and the demands of stakeholders (local governments, community groups, residents, local businesses, etc.). Few countries employ a formal framework, such as SmartRoads, and informal discussions with international traffic engineers suggest there is a strong demand for guidance.

As a result of this research being conducted, participants can benefit by gaining an understanding of how the SmartRoads framework impacts them directly, and how they may be able to better leverage the SmartRoads framework to improve their own operations or activities. In addition, the project results should provide benefits for interested stakeholders and road authorities in other jurisdictions.

PART 2 ANALYSIS

5 RESEARCH APPROACH & METHODS

We undertook stakeholder interviews as part of our case study research to evaluate the potential to expand the implementation of SmartRoads. The purpose of this multiple-case study design is to document feedback about the implementation of SmartRoads.

This required collecting data about the benefits of SmartRoads, how SmartRoads facilitates VicRoads in fulfilling its objectives, and constraints to the implementation of SmartRoads.

As indicated in Figure 1, there are several key stakeholders in the road traffic network, which is managed by TFV. Our case study research draws on the experience of some of these key stakeholders.

We conducted a themed content analysis on the stakeholder interview data. This is one of the most common methods used in qualitative research. It aims to find common patterns across interview transcripts. We undertook the following steps to conduct the analysis in this manner:

- Gaining familiarity with the data (reading and re-reading);
- Coding (labelling) the whole text;
- Searching for themes with broader patterns of meaning;
- Reviewing themes to make sure they fit the data;
- Defining and naming themes;
- Write-up and creating a coherent narrative that includes quotes from the interviewees.

5.1 Interview Data Collections

The primary data for the case study analysis was sourced by conducting interviews with 11 stakeholder groups in 10 organisations. These stakeholders include: councils within metropolitan Melbourne; public transport providers; a government authority; a consultancy; and VicRoads teams. For the purpose of maintaining confidentiality, these stakeholders have not been identified. Hence, stakeholders have been split into two groups: internal stakeholders (VicRoads) and external stakeholders.

The transcripts of these interviews, along with supplementary data, were used to build case studies on these 10 stakeholder organisations.

The questions addressed by the qualitative case study analysis are presented to the interviewee as general questions, allowing for elaboration with details. These questions relate to the following:

- Overview of use of SmartRoads by the Stakeholder;
- Experience prior to the implementation of SmartRoads;
- Experience of the implementation of SmartRoads;
- The impact of SmartRoads on the Stakeholder.

See Appendix A - Interview Questions for Stakeholders for a list of the general interview questions presented to the interviewees.

5.2 Secondary Data Collection

Some of the organisations, which participated in the case studies also provided documentation to support the information provided during discussions. Documents and other information provided at interviews consist of organisational charts, detailed project information at various stages of development, marketing information for prospective clients in global markets, and annual reports. We supplemented this documentation with publicly available information from the web sites of the respective organisations.

6 ANALYSIS & FINDINGS

The case study interviews reveal that if the implementation of SmartRoads were to be expanded across Australasia and overseas, several constraints in its implementation will need to be addressed. However, there is some evidence that various solutions to reduce these constraints are already being applied, while others are planned for the future.

The content of the case study interviews were analysed to identify the emergent common themes relating to the implementation of SmartRoads for the 11 case study groups. Apart from the implementation of SmartRoads over time, the most dominantly evident themes relate to how SmartRoads facilitates VicRoads in fulfilling its objectives (i.e., the benefits of SmartRoads), the factors assisting the implementation of SmartRoads and the constraints to the implementation of SmartRoads. The interviews also reveal that there are some solutions being applied to reduce the constraints to the implementation of SmartRoads. These common themes are discussed as follows.

6.1 Timeline of SmartRoads Roll-out to Date

6.1.1 Motivation for SmartRoads
In Melbourne, there are many shopping centre strips along key arterial roads, which are key activity centres, and traditionally, this is where many businesses have thrived. However, in the past, this has led to a conflict between movement (of traffic) and place (locations to spend time, especially in activity centres). Around a decade ago, VicRoads began to consider what kinds of tools and processes it could provide to its staff for managing changes to the road network, which allowed them to understand the implications of the movement of people within these places.

At the time, the Victorian Department of Transport was working on legislative change to bring about a consistent approach across all agencies, and in particular, VicRoads, in the form of the Transport Integration Act. This Act set a vision that recognised “the aspirations of Victorians for an integrated and sustainable transport system that contributes to an inclusive, prosperous and environmentally responsible State.”\(^4\) It dictates six transport system objectives: social and economic inclusion; economic prosperity; environmental sustainability; integration of transport and land use; efficiency, coordination and reliability; and safety, health and well-being. It also stipulates that decisions must be made integrating all levels of government and involve stakeholder and community consultation.

The ratification of the Transport Integration Act meant that VicRoads must give consideration to all of these factors when undertaking changes to the road network. Somewhat fortuitously, VicRoads was already developing the SmartRoads framework at the time (see next section). This meant that around 80% of the Transport Integration Act mandates were already being considered through the SmartRoads framework.

The implementation of SmartRoads involved engaging with 31 municipal councils and other stakeholders such as RACV, Bicycle Network Victoria, PTV and public transport operators. VicRoads approached the task by informing the stakeholders that the arterial roads are their responsibility and they would manage them but informed the councils about how they would be impacted.

VicRoads developed some basic SmartRoads “principles” and tested them in certain smaller areas and then worked with the local councils to rectify any identified issues. For example, they worked closely with the City of Darebin regarding the Northcote activity centre, where there was a local road which was functioning as an arterial road. VicRoads needed to provide platform tram stops on this road, so there was a large amount of discussion about the impact of these on the flow of traffic in the network and bypass routes, etc. Therefore, VicRoads tested the principles in that context and started to refine the framework through application.

VicRoads realised that it could learn through application and that as a principle, the framework should be scenario based, so that if there was the same context somewhere else, the framework should be able to be applied in the same way. This meant that VicRoads had to work through all the nuances, in terms of workshops and discussions. In some cases, it would host three or four detailed workshops to discuss the changes to the network and what the priority rules and principles would be. One of the senior strategy teams involved with SmartRoads at VicRoads believes that the reason for the high level of adoption of SmartRoads is that it has been developed in conjunction with all of these stakeholders.

6.1.2 Initial Implementation of SmartRoads

The Victorian Roads and Ports Minister formally launched SmartRoads in February 2010\(^5\), but in the two years prior to that VicRoads was engaged with many stakeholders to gain their inputs in the development of the framework. The first roll-out of SmartRoads was for new development projects, but now it is used for maintaining and operating the network efficiently. Figure 4 presents the processes involved in the implementation of SmartRoads over time.

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According to the VicRoads team, there was a requirement for all projects and proposals being developed to have a network fit assessment (NFA) conducted using SmartRoads (referred to as SmartRoads Network Fit Assessment). This was for all projects that would impact the road network based on specific criteria, e.g., if a proposal would add or reduce traffic volumes or have noticeable delays to traffic, trucks or public transport, or if a proposal would change access or amenity for pedestrians in an activity area or for bicycles on the principal bicycle network. This came into effect around five years ago, in order to assist to meet the needs of the Transport Integration Act. Furthermore, VicRoads started to look at how it could operate and manage the network better with SmartRoads, which is why signal route reviews were required to be undertaken using SmartRoads.

Therefore, SmartRoads is used for two processes: 1) Route reviews, which will always be conducted using the SmartRoads approach and now the new Movement & Place framework by a central team, and 2) roads development projects which will also now be using the new Movement & Place framework with assistance from the Movement and Place team. The core SmartRoads team oversaw the projects and Route Reviews and provided expert assistance and guidance to regional offices in order to ensure the processes were carried out correctly. Both projects and Route Reviews are transitioning to the Movement and Place framework which can be seen as the evolution of SmartRoads.

### 6.1.3 Current Implementation of SmartRoads

With time, as SmartRoads became better recognised and implemented internally at the higher strategic level, with more momentum behind it, its impact was more positive on VicRoads’ work. This was especially the case in the regional offices, because it helped staff to explain to external stakeholders how and why certain decisions were made by VicRoads. It provided the engineers with an ability to explain why certain priorities were assigned to certain modes and the impact of certain changes to routes.

Several municipal councils have indicated that with the new release of SmartRoads, VicRoads has been more forthcoming with information. For several metropolitan regions, VicRoads organises a regular meeting (every 6 months) with the various city councils in the areas. The councils are under the impression that VicRoads is making an effort to be more inclusive of the stakeholders.

### 6.2 Benefits of SmartRoads to Date

The case study analysis reveals several benefits from the implementation of SmartRoads, as discussed below:

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**Figure 4** Processes involved in the implementation of SmartRoads over time.
6.2.1 Acts as a ‘policy broker’

As in many areas of public policy, the stakeholders for Victoria’s road system can have very conflicting visions and aspirations for the road system. Often these stakeholders form coalitions advocating for their vision; in this case, often these coalitions advocate for a specific mode user such as motorists or cyclists. According to the Advocacy Coalition Framework, a ‘policy broker’ is required to bring together these coalitions and act as an impartial mediator that seeks reasonable compromise between the coalitions.\(^6\)

In the past, VicRoads was seen by many as a stakeholder advocating for motorists. One of SmartRoads’ most significant benefits is that it has allowed VicRoads to transition into the role of a policy broker.

The revitalisation of central Dandenong is one example of this role. There were many “key stakeholders at loggerheads” because they were all arguing with their own requirements in mind. For example, PTV wanted buses to go down certain routes, while the Council argued it wanted place-making along certain links. VicRoads staff were acting as an advocacy coalition, claiming that if Princes Highway becomes too congested in that area, there would be negative impacts on congestion. Therefore, VicRoads had to work past the issue of everyone arguing their own cases.

SmartRoads provided a tool to work beyond those loggerheads, making the trade-offs between coalitions more explicit. VicRoads itself then becomes less of an advocate for motorists and more of an impartial mediator. According to the VicRoads team, “in essence, SmartRoads is ... a common language between transport planners, civil engineers, urban designers”, which can facilitate the achievement of common goals.

In addition, SmartRoads has achieved is a well-defined structure, creating consistency by unifying the networks with a common language/terminology to describe multimodal traffic networks. This is important because it harmonises the practice of road traffic management, which leads to consensus building. What is unique about SmartRoads is that it provides a system of consistent terminologies, with consistent priority rules, which are encoded so as long as you classify the route correctly, the output from SmartRoads should be consistent.

6.2.2 Facilitates decision-making

Since the SmartRoads framework has improved the coordination among the various players, it has enabled a greater level of consensus, and thus helped decisions to be made more efficiently.

According to the VicRoads team, through the RUH, SmartRoads was able to provide a set of clearly defined strategic priorities along various arterial roads. This was very helpful to the VicRoads engineers because they themselves could see there is a strategic direction to follow. The engineers in the regional offices provided feedback to the VicRoads team that with the SmartRoads RUH, they had something solid to follow.

Therefore, the RUH and the NFAs allow VicRoads staff to see if proposed changes align with VicRoads’ objectives. For example, if a stakeholder such as a municipal council wants to add a bicycle lane to a road, but VicRoads is aware that this road is a major traffic route and adding the proposed bicycle lane would reduce the lanes available to vehicles, the proposed change would be expected to have a negative effect on the flow of traffic. However, SmartRoads is able to show to engineers exactly how much of an impact such a project would have, i.e., in terms of gap in LOS as determined by the NFA. Therefore, in such a case, the proposal would not allow VicRoads to achieve its objectives for the traffic route and an alternative solution would be required.

Also, based on feedback from VicRoads’ regional offices, around the time SmartRoads was first being implemented, the VicRoads team realised that while in the past such operations were left to people’s own judgements, now with SmartRoads they were able to make more informed decisions based on VicRoads’ strategic direction (RUH). They could estimate the level of impact of projects on the traffic network. That is, SmartRoads provided guidance to engineers.

6.2.3 Facilitates value-addition via use by external stakeholders

Learning to use SmartRoads Network Fit Assessment is a time-consuming process. For this reason, generally the NFA process is ‘owned’ and used by trained VicRoads staff. These trained staff members facilitate the use of SmartRoads through collaborative workshops. However, in recent years some external stakeholders have begun to use SmartRoads for their own purposes.

The VicRoads team mentioned that RUHs were originally developed only for arterial roads. However, through the process of engaging with councils (as those arterial roads intersected with local roads) some of them wanted to go further and do their own local road network RUH. This is because there were some significant (non-arterial) roads which had been overlooked in the initial RUH development. For example, it was obvious there were some roads that could clearly be designated as pedestrian priority areas.

More recently, some councils have started to use SmartRoads for strategic planning purposes as a useful tool to demonstrate to VicRoads how some arterial roads within their jurisdictions should be classified. For example, one particular council has started using SmartRoads for its strategic planning of pedestrian and bicycle routes, where it conducted some principal pedestrian network mapping, and then overlayed their preferred mapping onto the actual road network with the VicRoads RUH. The council presented this to VicRoads to put the case forward for changing the priority road rules for certain roads to make these pedestrian priority roads. This aligned with VicRoads’ method of working, since it allowed them to see how the changes could impact their preferred traffic route to a major arterial via a major intersection.

In another example, one council addressed road safety through the use of SmartRoads, by analysing how reduced speed limits will impact traffic flow and then putting the case to VicRoads to make the changes, which have since been implemented. Therefore, if councils can gain greater access to SmartRoads, it would allow them to be able to show and justify to its residents why certain projects have been implemented the way they have, e.g., changes in RUH to a particular intersection, which some residents may not be happy about due to them experiencing the effects of such changes. SmartRoads can be used to show that thorough analyses have been conducted in order to reach the implemented solution.

Local councils are not the only stakeholders that are engaging more proactively with SmartRoads. Other external stakeholders do not use SmartRoads for their operations relating to network performance. However, SmartRoads is used at a strategic level, as a platform for discussion with VicRoads. Therefore, external stakeholders usually have success in influencing VicRoads’ decisions by using SmartRoads to justify their arguments relating to priority routes, etc.

One particular external stakeholder operates in a high growth area, so it is currently being pushed to the limit by having to operate with a lack of infrastructure. The company is trying hard to lobby the Government to provide infrastructure, such as bus lanes, bus stops, and even bus priority for moving into lanes, to help them to be more efficient and increase patronage. As a result, the stakeholder participates proactively in VicRoads’ workshops using SmartRoads for route reviews and NFAs. The SmartRoads outputs can be used in the development of business cases to forward to TFV. The stakeholder argues that if it is given priority to provide its service and is supported with some infrastructure to enable its services to be more efficient and encourage patronage, the more people they can move off the road and through the network.

Finally, SmartRoads is now a rich source of data about traffic conditions on Melbourne’s road network. This information is provided for any stakeholders to use in their planning and modelling if they so wish.

6.2.4 Provides stakeholders with an understanding of VicRoads’ decisions on projects

The workshops enable stakeholders to understand VicRoads’ decisions even if they do not fully agree with them. For example, there was a bicycle project proposed by a municipal council, which wanted bicycle lanes added and designed in a certain way. However, going through the SmartRoads process with NFAs in a workshop allowed the council to see the negative impacts of their proposed design on the bus route, etc. Therefore, the workshops are valuable in obtaining feedback from the external stakeholders to make sure they are happy with (or at least understand) VicRoads’ approach prior to implementing any changes. So apart from educating and engaging the stakeholders, the workshops facilitate feedback.

Previously, prior to the implementation of SmartRoads, VicRoads would have undertaken route reviews without consultation of the local councils. One external stakeholder stated that the benefit of being involved in the SmartRoads route review process is that it is able to provide VicRoads with information about certain local operational conditions that may not come through in the data.

6.2.5 Facilitates stakeholder understanding of the implications of the data

According to the VicRoads team, as both internal and external stakeholders participated in more workshops, they could see the benefits and value of SmartRoads. That is, the more workshops the stakeholders attended, the more they understood the implications of the data. The VicRoads team noted that both internal (VicRoads staff) and external stakeholders appreciated being involved in the workshops because they could understand what they are doing and then felt encouraged to make a contribution to the project. Earlier on
when they would conduct workshops, they would ask people to come in half an hour earlier just to be able to explain to them what their plans were for the workshop and give an overview of SmartRoads.

### 6.2.6 Facilitates discussion of solutions for projects

One external stakeholder was involved in a series of workshops hosted by VicRoads to deal with some of the challenges it faced in the implementation of SmartRoads. VicRoads had issues where trams were crossing major roads, such as Victoria Parade. Since SmartRoads assigns trams with priority, there were major delays for cars caused on east-west routes. This particular external stakeholder assisted VicRoads by conducting “valuable” discussions with various stakeholders to consider if it was possible to make up for the delays caused to cars along the tram route or at other places on the network, or if it would be possible to consider another tram route serving the same community giving that priority instead.

### 6.2.7 Facilitates the shift in thinking and approach of VicRoads’ staff

The VicRoads team has seen that conducting workshops for projects using SmartRoads has helped to shift the views of many people within VicRoads about what they should focus on and how to incorporate the various modes on the road.

In the past, VicRoads had planned for its regional VicRoads offices to take on the whole process of route reviews. As a result, some staff were even seconded to the key SmartRoads team to learn about the process and then undertake projects on their own. However, in the VicRoads regional offices, since the staff have a large amount of work to do already, conducting NFAs and route reviews with SmartRoads is difficult because it requires time and technical knowledge. Therefore, for many projects in the regional areas, the key SmartRoads team staff would go to offices closer to the regional areas and be based there for several days at a time, to conduct workshops and give stakeholders a chance to discuss the development of the RUH, NFAs or route reviews.

### 6.3 Factors Assisting the Implementation of SmartRoads

The benefits of SmartRoads, which have been identified in the previous section, can be explained in part by some of the following factors.

#### 6.3.1 Extensive stakeholder consultation

From its inception, SmartRoads was developed and applied through extensive consultation with stakeholders. This consultation continues in the form of workshops whenever new projects are proposed or route reviews are conducted on existing corridors.

#### 6.3.2 Government endorsement

VicRoads has been able to implement SmartRoads across the road network in Victoria, with its priority rules and classifications, because it was able to obtain the endorsement of the State Government, and at the council-level, support from the local mayors. There are only two councils in the Melbourne metropolitan region that have not endorsed SmartRoads.

#### 6.3.3 Championing

With the state Government’s support, VicRoads has taken the lead in championing the SmartRoads framework to manage such a multimodal road traffic network. Andrew Wall (VicRoads) was the first champion of the SmartRoads framework. He has been supported by a passionate core team that have continued to advocate for SmartRoads, even as they have moved into other roles within the organisation.

### 6.4 Constraints to the Implementation of SmartRoads to Date

The case study analysis identifies several types of constraints that impact the implementation of SmartRoads. They can be categorised into principles-related, VicRoads-related, technical and applicability constraints, as discussed below:

#### 6.4.1 Principles-related constraints

Several of the constraints identified by the case study analysis relate to the principle-based nature of the SmartRoads framework.

##### 6.4.1.1 Conflict between stakeholders over RUH
As mentioned in 6.2.1, SmartRoads acts as a ‘policy broker’ between competing coalitions that advocate for the modes they represent. Although this reduces conflict, it does not eliminate it entirely.

For example, around train stations, bus operators want their bus stops right at the front, which is where the taxi companies want their taxi stand as well. Councils’ interests mainly lie with providing priority to pedestrians and bicycle users. However, at such public transport hubs, since VicRoads prioritises traffic flow through certain preferred routes, it will give priority to the public transport as opposed to pedestrians or cyclists.

One external stakeholder feels the conflict between public transport providers in seeking priority in the hierarchy remains an issue, as VicRoads doesn’t seem to want to deal with it. One external stakeholder feels that since the RUH is debated by those present at route review and NFA workshops hosted by VicRoads, usually it is the prominent stakeholder, e.g., tram operator, which is given priority. Another external stakeholder also is of this view, and states that at some VicRoads route review workshops, it has sometimes had to speak out on behalf of the local bicycle network, which did not have a representative present at the time, in order for cyclists to be considered as road users as well. Other external stakeholders believe that VicRoads’ decisions on priority assignments is very biased towards the more powerful public transport operators. However, they acknowledge that since trams can transport 170 people at one time, they should be given priority.

On the other hand, not all stakeholders experience this level of conflict during workshops. With regards to being involved in the development of the RUH and workshops, one council has indicated that its team did not experience any conflict or disagreement. The council’s RUH was very straightforward to develop and there wasn’t any need to argue with VicRoads about any of it, particularly because they were working together on a major redevelopment project early on to achieve a common goal. Although, there were some changes made to some roads, particularly around the bicycle routes, where the council was able to influence VicRoads to give more priority to bicycles. VicRoads agreed with the council because of its local knowledge and understanding of what worked better in a local context. The council was able to work well with the VicRoads officers at the time.

6.4.1.2 SmartRoads favours the dominant mode of transport

Some stakeholders view SmartRoads as a relatively simplistic tool because it tends to favour the existing dominant mode on the road. One particular stakeholder claims that on necessary projects, e.g., improvements to intersections, VicRoads is very good at applying the tool, but sometimes the simplistic approach to SmartRoads actually hinders its ability to make improvements which may benefit modes other than the dominant one.

One particular external stakeholder claims even though VicRoads may be making changes in line with the priority route requirements, such as adding T-lights for trams, it seems like there is more focus on ensuring better flow of cars. From the stakeholder’s experience, when VicRoads conducts its regular signal route reviews, it seems that they are trying to improve the flows of cars, rather than optimise the modes of transport that they are supposed to. Therefore, despite having the RUH in place, and particularly the tram priority routes, VicRoads still ends up being more concerned about ensuring the flow of cars, e.g., over preferred traffic routes.

6.4.1.3 Lack of consideration for on-street parking

Councils are very concerned with on-street parking and often there is conflict between councils and public transport operators over road use priority because for example, clearways near local activity centres limit on-street parking, which in turn impacts patronage to local retailers/services.

SmartRoads lacks consideration for parking management on arterial roads. Therefore, there is no framework within SmartRoads for the State government to strategically manage parking. For example, as mentioned by one council, on a particular arterial road, there may be sections of clearway and then at another arterial road, there will be no clearway, so even though it is a traffic priority route.

6.4.2 Applicability Constraints

The constraints identified by the interview analysis also relate to the applicability of the SmartRoads framework to the management of the road traffic network in other cities or countries.

6.4.2.1 Institutional constraints

VicRoads was successful in implementing SmartRoads because it was accepted at and endorsed by the highest level of government in the State. However, in other states, SmartRoads (or its equivalent) has only
been used at an operational level, since it has not been mandated institutionally. Even when SmartRoads has been implemented in these states, it has been difficult to sustain its use since resources are required in order to conduct SmartRoads analyses.

6.4.2.2 Lack of locally-relevant priority rules and classifications

VicRoads originally defined the priority road use rules, through consultation with various stakeholders. The rules themselves are relatively straight forward, but the challenge is balancing the simplicity of the priority rules with the complexity of multimodal traffic networks. That is, although there are many types of roads in the network, there is a limited number of classifications for types of roads in SmartRoads. New Zealand has revised these, and has developed and introduced new terminologies, e.g. new classifications of bicycle lanes, such as municipal cycle lanes, etc. Therefore, although the Austroads LOS framework is in place, it needs to be reviewed and revised, as the roads authority in New Zealand is currently doing, to make the LOS definitions locally-relevant.

6.4.2.3 Lack of relevance to local government

Even if stakeholders such as municipal councils were able to overcome their resource constraints and were able to use SmartRoads, it would only have a limited usability because it is focused on the arterial roads and arterial road intersections. The use of SmartRoads by municipal councils is limited because arterial roads within their jurisdictions are under the management of VicRoads. So, unless councils are dealing with an issue that impacts an arterial road, SmartRoads is not as useful because its RUH is not established for local roads. However, VicRoads invites the relevant municipal councils to workshops when conducting route reviews in order to obtain feedback form these councils which have knowledge of the local roads, intersections, and places, etc.

6.4.2.4 Limitations in low-conflict areas

The genesis of SmartRoads arose from the conflict between various modes on Melbourne’s road network. In particular, VicRoads needed a tool to help manage the pressures of increasing congestion and the added complexity of on-road trams.

However, not all parts of Melbourne’s network experience this level of conflict between different road users. The use of SmartRoads may not be necessary for relatively simple road networks with few conflicts between modes. Indeed, the resources required to run a full NFA may disincentivise its use in some areas where more straightforward tools are sufficient.

6.4.2.5 Limitations in high-conflict, high-congestion areas

Although SmartRoads makes the trade-offs between modes more explicit, some of the municipal councils believe that there is a limit to how much value SmartRoads can add. For example, there are major arterial roads, which are operating at capacity in some councils’ jurisdictions, so these routes cannot be operated in a more efficient manner.

One particular council claims that SmartRoads has not made a great deal of difference because there are public transport modes carrying people from the East and North through to the CBD in the morning and vice-versa in the afternoon. As a result, all of the council’s roads are very congested. While the council understands the logic of SmartRoads, it claims that SmartRoads does not really have a practical application because every one of the council’s arterial roads has both trams and cyclists competing to use its roads.

Another external stakeholder also acknowledges that for Sydney Road for example, SmartRoads assigns it as a priority tram route and a priority bike route, but also a non-preferred traffic route. It is also a pedestrian priority ‘place’. Therefore, the issue is that in SmartRoads, it is possible for more than one mode to have priority, so it does not help to decide on the objectives of the road. According to this particular external stakeholder, “SmartRoads is too broad, and is not able to say if there is a situation with multiple priority modes, which one should be given priority over the others”.

6.4.2.6 Retrospective application of RUH considerations

One external stakeholder claims that a long-standing frustration is that VicRoads tends to be “relatively reactionary” (due to resources). There is a belief that much of VicRoads’ projects are driven by requirements of the government to fund works or they are dealing with a specific issue at a specific intersection, so the stakeholder finds that the project or the improvement has already been determined for VicRoads. Therefore, this stakeholder often has to retrospectively apply the SmartRoads RUH considerations to a project that already has been determined. As a result, the stakeholder feels that VicRoads cannot be fully strategic in assessing a project, suggesting that the solution is suboptimal.
6.4.3 VicRoads-related constraints

Some of the constraints identified by the interview analysis relate to VicRoads’ internal culture and governance structure.

6.4.3.1 VicRoads’ change-resisting internal culture

The bureaucratic process model assumes that the dominant characteristic of organisations is resistance to change\(^7\). The present study provides evidence of a change-resisting internal culture at VicRoads, which has constrained the efficient and effective implementation of SmartRoads. There is some evidence to suggest that VicRoads has an internal culture which resists change. Some external stakeholders occasionally use SmartRoads to make a case to VicRoads for a certain change. In such cases, the external stakeholders work with VicRoads in a workshop. In one particular case, although VicRoads dedicated several members of its team to help the external stakeholder, progress on the project ground to a halt. This is because the particular stakeholder was not concerned about the flow of traffic from the perspective of cars, but rather were pushing for the movement of people, preferably via bicycles or walking. However, the stakeholder claims that there were some within VicRoads, the “resisters”, who were not willing to consider that arterial roads should be used for anything other than moving cars.

Furthermore, another external stakeholder acknowledges that VicRoads has matured enormously by meeting its objectives to move cars across a road network to moving people but says it has not yet become the advocate and champion for the outcomes that SmartRoads should be achieving. Therefore, VicRoads tends to resist changes in the network, while attempting to show that the performance is still acceptable. The external stakeholder claims that while VicRoads does not make the network worse, it does not necessarily make it better and narrow the LOS gap either. It claims that, for a proposed change, even if the impact on the flow of cars was going to be large, but acceptable, VicRoads tends not to make changes. However, the stakeholder acknowledges that politically it is difficult to make changes.

6.4.3.2 Not considering the whole network

There is also some evidence to suggest that VicRoads uses SmartRoads without considering the impact of a project on the overall network. One external stakeholder claims that in a project it was working on with VicRoads, where there was limited funding provided to VicRoads. The stakeholder wanted to make certain improvements to the network, but these were not covered by the budget, so it asked VicRoads to design the full road, and then the stakeholder could advocate for the additional funds. However, VicRoads only carried out the works on the road which were able to be covered within the budget.

Another external stakeholder claims that VicRoads has left a large gap in knowledge by not using SmartRoads to provide a performance assessment of the current state of the entire road traffic network. This has never been presented in any single document by VicRoads.

One external stakeholder also notes that there is a lack of a holistic view of the whole network because VicRoads is not being driven by the right objective in undertaking the work. For example, if VicRoads uses SmartRoads to appraise where the transport network is least effective, it should be pursuing these problem areas to improve them. Instead, VicRoads is conducting the route reviews, without specifically targeting a route which has been identified as problematic. SmartRoads is not being used to systematically identify the difference between what is actually happening and what the policy objective is for that piece of transport infrastructure. They understand that it is possible to apply SmartRoads to several locations, and this would provide a very interesting feedback about where the performance gaps on the network are.

6.4.3.3 VicRoads’ internal restructure

During earlier restructuring at VicRoads, the implementation of SmartRoads continued. However, with the mandate for SmartRoads to be included in every project and the fact that there was not one central team keeping tab of them, the implementation slowed down. Since then, there have been several changes but the central SmartRoads team has been brought back together. This indicated that the initial distribution of the implementation may have been a bit early but now it has become embedded in the organisation.

According to the VicRoads team, although the original VicRoads team that was involved in SmartRoads was moved into other areas of responsibility due to organisational restructuring, these officers would still offer support. At times, these officers would also facilitate route review workshops to observe and ensure that the new team was understanding and applying the process correctly.

With regards to the recent formation of TFV, some officers who were involved in SmartRoads planning at VicRoads were moved to TFV. According to the VicRoads team, the movement of staff in and out of VicRoads has not really impacted the implementation of SmartRoads because mostly those involved have been permanently placed in the organisation.

One particular external stakeholder claims the most recent restructuring VicRoads has undergone has made it more difficult for them to liaise with VicRoads, as previously they had one point of contact in VicRoads for everything related to a project. However, now the nature of the issue within a project determines which team in VicRoads the stakeholder has to contact. This makes it difficult to some degree for stakeholders to make contact with VicRoads.

6.4.4 Technical constraints
Other constraints identified by the case study analysis related to technical aspects of SmartRoads.

6.4.4.1 High resource requirements of SmartRoads
SmartRoads requires both technically skilled users and large amounts of data.

- Technically-skilled human resource requirements:
  - The SmartRoads application is not user-friendly and has been described by some external stakeholders as “clunky” and inaccessible. It does not allow editing and also uses stick figures. Some stakeholders have indicated that they have not been offered or sought training for its use, but at the same time they do not have the capacity to take on any activity using SmartRoads.
  - Using the current version of SmartRoads, conducting a NFA (identifying the gap between the target LOS and current LOS) can be technical and time-consuming. Most of the municipal councils do not have the staff with the relevant skills or time to use SmartRoads. This means that few organisations outside VicRoads can perform their own NFAs. For example, one of the external stakeholders (a council) does not have the human capital with the relevant skills to devote towards such activities, and thus has not used SmartRoads. It has only participated in route reviews and NFAs at the VicRoads office with several VicRoads technical staff present who conduct the exercise by using the SmartRoads software. Any time the stakeholder requires some information that SmartRoads can calculate, it is done by VicRoads.

- Data requirements:
  - SmartRoads requires large amounts of data and effort in order for it to conduct analyses to solve certain problems, which could be done in separate analyses. It takes a great amount of time to conduct the analysis with SmartRoads to get the output for even one intersection, and often there are requirements by SmartRoads to re-enter information, which it deems incorrect. Therefore, users need to allocate financial resources for the collection of the required data.
  - Some external stakeholders claim they do not have all the traffic data required to do a SmartRoads NFA, although it is more available than it used to be. These stakeholders also do not have the time to dedicate to such network assessments.
  - One particular external stakeholder claims SmartRoads is a good tool for establishing the most efficient way a particular intersection can operate, as long as data is provided for all modes of transport. SmartRoads is useful only to the extent that there is data available. So, its predictive ability is not good when there is not data on foot traffic, for example, and thus, it may make a poor assessment. Some external stakeholders have identified that the problem is not necessarily with the SmartRoads framework itself, but the assessment due to the lack of availability of data for certain modes of traffic. Therefore, SmartRoads is only as good as the data that is used for inputs.
  - Furthermore, the VicRoads team was made aware by the stakeholders at workshops that there is a large amount of work and data required to undertake the NFAs using the SmartRoads framework. VicRoads has been developing a solution to auto-populate as much of the data in the software/application as possible. However, they have not been able to reach the level that they wanted to achieve, because for NFAs good quality data is needed, which is well-validated and time and location-specific. The quality of data is important for making informed decisions.

6.4.4.2 Lack of predictive ability
Currently, when performing an NFA, changes to the LOS need to be estimated outside of the NFA software. This is because the NFA software cannot predict changes to the road network, so estimations still have to be done outside of the program and then input manually.
One external stakeholder argues that if SmartRoads can assist in freeing up the road network over a projected period, e.g. reduce congestion by three or four percent, then that could go a long way for the Company with its scheduling. Therefore, what SmartRoads can do is, with the exception of the occasional heavy traffic days, is to make the network more predictable, so smaller problems can be rectified, leading to much better efficiency overall.

6.4.4.3 Lack of GIS capabilities

The SmartRoads framework incorporates a schematic diagram of the network in the tool, so it is possible to assess smaller portions of the network. However, an external stakeholder points out that it does not have any live real-time data that could be used for an evaluation. Since SmartRoads was originally developed for local site-specific projects, there was no need for geolocation capabilities, but now that it is being applied to greater areas, GIS capability is required. The current version of SmartRoads (Version 7) has only a rudimentary GIS interchange ability, where shapes, etc., can be converted into a GIS file format.

Furthermore, once users realise that it is possible to replicate and carry out the same functions of SmartRoads using GIS or Excel, they may not find any value in implementing SmartRoads. That is, the logic and mathematics behind SmartRoads is simple. This would not be a good outcome though, as in New Zealand, where each city has its own priority rules, etc., and as a result, SmartRoads has to be revised each time a new city implements it.

6.5 Addressing Constraints to Implementation of SmartRoads

The research team’s interviews of the various internal VicRoads and external stakeholders of SmartRoads has revealed evidence that there are some solutions being applied to reduce the constraints to the implementation of SmartRoads. Some of these examples are discussed as follows.

6.5.1 Upgrades to NFA software

A number of initiatives are currently taking place to upgrade and streamline the NFA software.

6.4.1.1 Addressing a lack of predictive ability

Currently, when conducting an NFA, the user has to estimate the impact of a proposed change to the network. The impact is manually calculated based on the treatment by using microsimulation or expert judgement in a workshop environment. The lack of this predictive functionality is a key limitation of SmartRoads. Many jurisdictions or users want this to be addressed. An external stakeholder is working to include this sort of functionality in the new tool that it is developing. Since SmartRoads was never intended to be a modelling tool, this stakeholder is developing a treatment library, which will contain a list of treatments and corresponding impacts that can provide a guide to an estimated level of impact. For example, the implementation of a pedestrian crossing would have a known impact (positive) on the road traffic network. This is where the stakeholder is trying to make improvements, so the tool is more predictive.

6.4.1.2 Addressing the lack of GIS capabilities

A new version of SmartRoads is being developed by an external stakeholder that will allow the route map to be located onto an aerial map and will correspond with the real network. The GIS capability will enhance SmartRoads by also reducing the cost of doing a SmartRoads analysis. Also, the stakeholder is seeking to solve the rudimentary GIS interchange ability issue of SmartRoads in the newer Version 8, so that there is a full GIS interchange capability.

6.5.2 Addressing issues with multiple priority modes

Currently, if more than one mode is assigned priority in the road user hierarchy, it is difficult to determine a hierarchy of priority between those modes. Only ‘general traffic’ is assigned varying priority levels. This issue should be addressed as SmartRoads is integrated into the new Movement & Place framework (described in section 6.6.1 below).

6.5.3 Addressing VicRoads’ internal culture

According to the VicRoads team, with regards to the acceptance of SmartRoads internally at VicRoads, earlier on it was more difficult as there was not as much understanding about the objectives of applying the SmartRoads framework. However, with time, as more people became involved in the process, it got easier as people’s thinking changed. They were able to see how useful it is to use this process. Over time, these internal VicRoads staff became more involved and learned more by bringing them all together in the workshops to see how the SmartRoads framework would impact each of the external stakeholders.
Therefore, the route review workshops played a significant role in shifting the views of many people within VicRoads about what they should focus on and how to incorporate the various modes on the road.

6.5.4 Addressing the high resource requirements of SmartRoads

Stakeholders are now overcoming the issue of the technical knowledge requirement of SmartRoads by enlisting the services of consultants (who have learned how to use SmartRoads by obtaining training from VicRoads) for conducting technical analyses that can be used for road traffic planning and management projects. According to the VicRoads team, consultants that are contracted to councils are usually proficient in using SmartRoads now because they have had enough exposure to it and been given training by VicRoads. Several years ago, VicRoads conducted a training session for consultants. This has also been done on a smaller scale for councils, etc. Now consultants come to VicRoads for one-on-one engagement to obtain training over a few hours. One particular council has relied on consultants, who have obtained training from VicRoads, to do the technical modelling using SmartRoads. However, the council has had to allocate a large budget for this.

6.5.5 Addressing a lack of locally-relevant LOS definitions

According to an external stakeholder, every jurisdiction is now making their own revisions to SmartRoads, using the original SmartRoads framework developed by Australian Road Research Board (ARRB) as a template, which is a positive move since it is suited to the local users.

6.6 The Future of SmartRoads

The most significant change to SmartRoads in the near future is its evolution into the Movement & Place framework. The future of SmartRoads also lies in the further development of the framework to address the constraints that have been identified.

6.6.1 The development of Movement & Place

SmartRoads was developed to manage the conflicting movement requirements of different modes. It did not consider safety, the environment, accessibility or place-making. ‘Place’ was only measured indirectly by defining pedestrian priority areas.

The newly developed Movement & Place framework is the next evolution of SmartRoads. Based on the ‘Link & Place’ framework initially developed in London8, Movement & Place extends on SmartRoads by considering not just movement but also safety, environment, accessibility and place-making. Therefore, NFAs (and thus decisions), will be based on not only the mobility function of roads, but also these other factors. Movement & Place can be referred to as an integrated system of planning for traffic management. It also addresses more of the Transport Integration Act, which mandates an integrated decision-making framework.

Appendix B provides tables that explain the level of service determination in SmartRoads and application of Movement & Place.

One particular external stakeholder explains that Movement & Place defines exactly how important a particular mode is based on its function such as either moving larger amounts of people across longer distances or smaller numbers of people in shorter distances. Movement & Place aims to provide more definition around the ‘place’ function of a road.

In addition, Movement & Place also has multiple categories of priority for each travel mode (e.g., tram priority is assigned as T1, T2, T3). This is an improvement on the earlier version of SmartRoads where only general traffic was provided a range of priority emphasis. This change in the M&P framework helps to resolve issues where one stretch of road is assigned priority to multiple modes. For example, in the original NFA if a road assigned priority to both bus and tram, there was no distinction between them. In the M&P framework, a T1/B2 road implies that trams should have higher priority than buses.

According to an external stakeholder, Movement & Place will allow the real benefits of SmartRoads to be seen. This is because Movement & Place sits above SmartRoads, which is already managing mobility, but now Movement & Place brings safety, environment, accessibility and place-making, which allows decisions to be based on more factors and makes it clearer what the impacts of the decisions are on these factors.

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A benefit of Movement & Place is that it articulates the benefit costs that are not realised during the usual benefit-cost ratio assessment, and these are aspects around the people and community. It also allows for identification of future impacts, and how the network should shift from now and into the future. Usually, this is recognised as economic benefits. However, Movement & Place is an intelligent way of identifying the benefits without necessarily specifying the financial benefits associated with it.

### 6.6.2 Further development of SmartRoads

Section 6.5 has already discussed how some of the constraints of SmartRoads are being addressed. However, further developments of SmartRoads are possible. One external stakeholder states that although Movement & Place is the next natural step, it would like to see SmartRoads evolve from being a tool used for projects that people have already identified as having issues in being the tool used to generate the projects, i.e., identifying where the problem areas are and issues that need to be addressed.

Furthermore, according to VicRoads, ARRB is developing a version of SmartRoads that can be applied nationally in each state. Each jurisdiction will be contributing with their own RUHs. This is why adding a GIS component would be useful, because it makes supplying the data to the SmartRoads application easier.

The VicRoads team has suggested that it would be good to have funding allocated at both the Austroads and federal levels to implement a framework that can demonstrate relativities across the entire Australian map to compare similar types of key roads, activities centres, etc. in different cities. Such a framework would provide a consistent level of service through providing a common language, which may be more difficult to achieve than developing the framework because the framework can be customised by setting acceptable levels of service, but what one jurisdiction considers as acceptable may not be the case in another. Therefore, there would be a need for guidelines to be developed.

### 6.7 Summary of the Findings

As discussed above, the key themes that emerge from the case study interviews relate to how SmartRoads facilitates VicRoads in fulfilling its objectives (i.e., the benefits of SmartRoads), the factors assisting the implementation of SmartRoads and the constraints to the implementation of SmartRoads. The key factors identified within each theme are summarised in Table 2.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Key Factors Identified within theme</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Timeline for roll-out of SmartRoads</strong></td>
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<td></td>
<td>Motivation for SmartRoads</td>
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<td></td>
<td>Initial implementation of SmartRoads</td>
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<td>Current implementation of SmartRoads</td>
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<tr>
<td>2</td>
<td><strong>Benefits of SmartRoads to date</strong></td>
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<tr>
<td></td>
<td>Act as a ‘policy broker’</td>
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<tr>
<td></td>
<td>Facilitates decision-making</td>
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<tr>
<td></td>
<td>Facilitates value-addition via use by external stakeholders</td>
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<tr>
<td></td>
<td>Provides stakeholders with an understanding of VicRoads’ decisions on projects</td>
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<tr>
<td></td>
<td>Facilitates an understanding the implications of the data by stakeholders</td>
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<td></td>
<td>Facilitates discussion of solutions for projects</td>
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<td></td>
<td>Facilitates the shift in thinking and approach of VicRoads’ staff</td>
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<tr>
<td>3</td>
<td><strong>Factors assisting the implementation of SmartRoads</strong></td>
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<tr>
<td></td>
<td>Extensive stakeholder consultation</td>
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<td>Government endorsement</td>
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<td></td>
<td>Championing</td>
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<tr>
<td></td>
<td>Principles-related constraints:</td>
</tr>
</tbody>
</table>
**Constraints to the implementation of SmartRoads to date**

- Conflict between stakeholders over RUH
- SmartRoads favours the dominant transport mode
- Lack of consideration for on-street parking

**Applicability constraints:**
- Lack of conflict between infrastructure
- Institutional constraints
- Lack of locally-relevant priority rules and classifications
- Lack of relevance to local governments
- Limitations in low-conflict areas
- Limitation in high-conflict, high congestion areas
- Retrospective application of RUH considerations

**VicRoads-related constraints:**
- VicRoads’ change-resisting internal culture
- Not considering the whole network
- VicRoads internal structure

**Technical constraints:**
- High resource requirements of SmartRoads
- Lack of predictive ability
- Lack of GIS capabilities

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**Addressing constraints to the implementation of SmartRoads**

- Upgrades to NFA software
- Addressing issues with multiple priority modes
- Addressing VicRoads’ internal culture
- Addressing the high resource requirements of SmartRoads

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**Table 2 Summary of the common themes identified in stakeholder interviews.**

With regards to the implementation of SmartRoads, it is apparent that there are both factors facilitating and factors constraining the implementation. However, despite the conflict presented by these facilitating and constraining factors, there is evidence that these constraints are being addressed with various solutions to reduce these constraints already being applied, while others are planned for the future. These solutions are listed in Table 3.

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Lack of GIS capabilities</td>
<td>Newer version of SmartRoads will have improved GIS capabilities, including GIS interchange capability</td>
</tr>
<tr>
<td>2 Lack of locally-relevant LOS definitions</td>
<td>Various jurisdictions now making their own revisions to the LOS definitions in SmartRoads.</td>
</tr>
<tr>
<td>3 High resource requirements of SmartRoads</td>
<td>Technically-trained consultants to be engaged with VicRoads on behalf of Stakeholders</td>
</tr>
<tr>
<td>4 Lack of predictive ability</td>
<td>Newer version of SmartRoads will include a treatment library, which will list of treatments and corresponding impacts that can provide a guide to an estimated level of impact.</td>
</tr>
<tr>
<td>5 Lack of applicability with multiple priority modes</td>
<td>Movement &amp; Place defines exactly how important a particular mode is based on its function, such as either moving larger amounts of people across longer distances or smaller numbers of people in shorter distances.</td>
</tr>
<tr>
<td>6 VicRoads’ change-resisting internal culture</td>
<td>Route review workshops play a big part in shifting the views of many people within VicRoads about what they should focus on and how to incorporate the various modes on the road.</td>
</tr>
<tr>
<td>7 VicRoads’ internal culture limiting view of whole network</td>
<td>Movement &amp; Place is a better tool for the purpose of strategic planning, because it considers the whole network.</td>
</tr>
</tbody>
</table>
Table 3 How some constraints to the implementation of SmartRoads are being addressed.

PART 3 DISCUSSION & CONCLUSIONS

7 DISCUSSION OF THE FINDINGS

The aim of this research project was to examine the factors that may facilitate expanding the potential for SmartRoads to improve road network performance. In order to do so, it has: examined how SmartRoads has evolved and been implemented in Victoria; how SmartRoads assists VicRoads in fulfilling its objectives in line with the Transport Integration Act; identified the factors that facilitate the implementation of SmartRoads; and identified the factors that constrain the implementation of SmartRoads.

Overall, the stakeholder interviews have revealed that the implementation of SmartRoads has not been as much of an issue as some of the external stakeholders have made it out to be. Over time, despite undergoing several changes in the governance of the implementation of the SmartRoads framework, the system for managing the road traffic network now seems to be working efficiently. The internal restructuring has also impacted movement of staff within VicRoads, but this has not seemed to have any long-term effects. In the short-term, restructuring within VicRoads delayed the implementation because it occurred before SmartRoads was fully embedded in the organisation. However, once this was recognised, a strong team was once again brought together, and in the long-term, SmartRoads is being used for both new roads development projects and the maintenance of the road traffic network.

With regards to making SmartRoads more efficient and effective, the research project has revealed that apart from the factors currently assisting the implementation of SmartRoads, there are solutions which are currently being applied or are planned to be applied in future developments of SmartRoads.

8 ADVICE FOR JURISDICTIONS IMPLEMENTING SMARTROADS

The SmartRoads framework is currently being implemented, in various forms, in parts of South Australia, Queensland and New Zealand. Based on the results of this project, we suggest that jurisdictions consider the following points if they wish to facilitate a smooth transition into using this framework:

8.1 The importance of champions and internal culture

For many road authorities, transitioning to an integrated, multi-modal view of roads can be a significant change to internal structure and culture. Such a significant change will be greatly facilitated if there is a clear ‘champion’ for this change, particularly if this champion is in a position of authority.

8.2 High initial resource requirements

Setting up a Road User Hierarchy and Network Fit Assessment is a resource- and time-intensive activity. VicRoads provides the NFA software free of charge, but it can take a long time to manually create a city’s road network, import Level of Service ratings and vehicle flows. Although there are now systems in place that can help this process, organisations should be aware of this initial investment of time.

8.3 The need for thorough and genuine consultation

One of the great benefits of SmartRoads is that it facilitates genuine consultation with road stakeholders such as local councils, public transport authorities and mode advocacy groups. However, all community consultation does take additional time as each stakeholder needs to be educated about how the NFA process works.

9 FUTURE DIRECTIONS

This research project has opened up the opportunity for further research on the impacts of SmartRoads and the potential for its expansion. The exercise of conducting the case study interviews has enabled the research team to develop an understanding with the various stakeholder groups, which facilitates the idea of further discussions in the future.

Since few countries employ a formal multimodal road management framework, there is potential for SmartRoads to be implemented in various jurisdictions around Australasia and around the world if the identified constraints are reduced or resolved, as discussed.
Therefore, the next phase of this project could be an examination of the potential for SmartRoads, along with the new Movement & Place framework, to be implemented in a particular new jurisdiction. This could entail a case study analysis of the key stakeholders within a particular jurisdiction and an analysis of how SmartRoads may be applied and how effective it may be in the planning and management of road traffic network in that area.

In the meantime, this research project could be followed up with the development of an academic journal paper, which examines the literature and applies a theoretical framework.

10 CONCLUSIONS

Melbourne is ranked as the world’s most liveable city. Since public transport is a key determinant of the liveability of a city, VicRoads has made a key contribution to Melbourne’s liveability by maintaining the public transport network such that it aligns its objectives to the Transport Integration Act.

TFV mandated, through the Transport Integration Act, that VicRoads give consideration to all factors when considering making changes to the road network, which included priorities for various modes and how those changes impact places. The development and implementation of the SmartRoads framework, and now Movement & Place, has helped VicRoads to deliver its objectives to the State government, such that when making changes to the road traffic network, VicRoads uses the principles-based framework of SmartRoads to make decisions.

SmartRoads provides a common language that allows various key stakeholders of the road traffic network to agree upon certain objectives. With Movement & Place, VicRoads has developed a more specific framework, which integrates multimodal mobility with safety, place, accessibility, environment, etc., which is unique in the transport industry.

Despite the identified constraints to the implementation of SmartRoads, if the mentioned solutions and others that are planned for the future are implemented, then along with the new Movement & Place framework, SmartRoads can become an efficient and effective framework for the planning and management of the road traffic network not only in Victoria, but also in other Australian states and overseas.
APPENDIX A

A.1 Interview Questions for Stakeholders

Overview of use of SmartRoads by the Stakeholder:
- How does your organisation make use of SmartRoads?
- Do you provide inputs and feedback to VicRoads about SmartRoads?

Prior to the implementation of SmartRoads:
- What was the main driver for the decision to utilise SmartRoads?
- What were challenge in traffic management?
- Were other tools used previously?
- Before deciding to adopt SmartRoads, how did you learn about SmartRoads? Did you see it in use somewhere else?
- What benefits were you expecting from SmartRoads?

Experience of the implementation of SmartRoads:
- To what extent have you been using SmartRoads?
- When is SmartRoads used and when is it ignored?
- Why doesn't every project use the SmartRoads tool?
- In your opinion, why is there a lack of stakeholder buy-in?
- Are there resource constraints that impact your organisation’s own involvement?
- What were the challenges relating to your expectations? E.g. SmartRoads is data-hungry.
- Are there cases when there are conflicts with other SmartRoads stakeholders?

The impact of SmartRoads on the Stakeholder:
- Does the SmartRoads framework address your requirements?
  - If Yes, then how?
  - If no, then in your opinion, how can the SmartRoads framework be improved to address these requirements?
- What are the positive effects of the SmartRoads framework
  - in facilitating your operations/activities?
  - on your consumers/customers?
- What are the negative effects of the SmartRoads framework
  - in facilitating your operations/activities?
  - on your consumers/customers?
  - In your opinion, how can these negative effects be mitigated?
- What has the overall impact of the SmartRoads framework been on your organisation?
- From your organisation’s perspective, does SmartRoads improve road network performance?
# APPENDIX B

## A.2 LOS Determination for NFA for M&P

<table>
<thead>
<tr>
<th>Transport type</th>
<th>LOS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General traffic &amp; freight on arterial roads</td>
<td>A</td>
<td>Generally free flow conditions with operating speed at least 80% of the posted speed limit. Vehicles are unimpeded in manoeuvring in the traffic stream and delay at intersections is minimal.</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Relatively unimpeded flow with operating speed between 50-80% of the posted speed limit. Manoeuvring in the traffic stream is only slightly restricted and intersection delays are low.</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Stable operating conditions but with manoeuvring becoming more restricted and motorists experience appreciable tension in driving. Operating speeds are between 30-50% of the posted speed limit. At signalised intersections, vehicles generally have to stop in a queue but clear the intersection in 1 signal cycle.</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Small increases in traffic volumes can significantly increase delay. Operating speeds are between 20-30% of the posted speed limit. At signalised intersections, vehicles always join the back of an existing queue and take about 2 signal cycles to clear the intersection.</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>Conditions are characterised by significant delays with operating speeds between 10-20% of the posted speed limit. At signalised intersections, vehicles take 3 or more signal cycles to clear the intersection.</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>Traffic flow at this level is at very low speeds (less than 10% of the posted speed limit). At signalised intersections, vehicles can take 3 or more signal cycles to clear the intersection and backups from downstream significantly impacts traffic flow.</td>
</tr>
</tbody>
</table>

Table 3.5 Level of Service for General Traffic & Freight on Arterial Roads

(Source: VicRoads)
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