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Facilitating Network Operations Planning: A Case Study of the VicRoads SmartRoads Framework

Sairah Hussain[1], Alexa Delbosc[2] and Amrik Sohal[1]

[1]Monash Business School, Building N 27 Sir John Monash Drive Caulfield VIC 3145

[2]Department of Civil Engineering Monash University, 23 College Walk, Clayton VIC 3800

Email for correspondence: Alexa.delbosc@monash.edu

Abstract

An increasing number of jurisdictions are seeking new ways to manage the competing needs of different modes on increasingly congested road networks. Network Operations Planning (NOP) is becoming 'best practice' in managing multi-modal transport networks. This paper presents a critical review of the implementation of SmartRoads, an NOP framework developed by VicRoads. The aim of the research is to gain an understanding of the key factors that constrained and facilitated the implementation of SmartRoads. A theoretical framework is developed based on the integration of the theories of institutional legitimacy, organisational champion and stakeholder engagement. The research utilised interviews with both internal and external stakeholder to identify key benefits, constraints and facilitators. The findings of the analysis suggest that the successful implementation of such frameworks requires legitimacy at the institutional, organizational and external stakeholder levels, which is facilitated by government endorsement, championing and stakeholder engagement, respectively.

1. Introduction

Like many growing cities, Melbourne has experienced rapid growth, with different modes of transport competing for limited road space. Many cities struggle to balance the competing directives to improve travel time for cars, facilitate on-road public transport, and encourage walking and cycling. Network Operations Planning (NOP) is becoming 'best practice' in managing complex, multi-modal transport networks and is now promoted in national practice (Austroads 2016). SmartRoads, an example of a NOP framework, was developed by VicRoads and is used to explicitly manage the trade-offs between transport modes, integrating community and stakeholder input and measuring expected outcomes in the road network.

Yet the implementation of SmartRoads within Victoria was a gradual process, taking around ten years to be fully embedded in the organisation. Initial discussions with VicRoads revealed that some barriers slowed the effectiveness and implementation of SmartRoads. 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 the road authorities in Australasia that have recently begun to implement SmartRoads-based network operation planning.

This paper draws on the management and implementation literature to critically examine the implementation of SmartRoads in VicRoads. The aim of the research is to identify the key factors that constrained and facilitated the implementation of SmartRoads. A theoretical framework is developed based on the integration of the institutional legitimacy, organisational champion and stakeholder theories. The research involved an analysis of both internal and external stakeholder interviews to identify these factors.

The paper continues with a description of the SmartRoads framework before reviewing the literature on implementation and organisational legitimacy.

1.1 What is SmartRoads?

VicRoads is the statutory authority responsible for managing Victoria's freeways, urban and some non-urban arterial roads, and some none-arterial state roads. SmartRoads is an operational framework developed by VicRoads to help manage the trade-offs between modes competing for limited road space.

Since most roads are not wide enough to allow for all modes of transport to have priority, a hierarchy is needed. SmartRoads relies on the Road Use Hierarchy, which is a set of guiding principles that allocates priority road use by transport mode. The Road Use Hierarchy guides planners about the function of the road and it is defined by mapping the road user priorities on maps of municipal council areas. Once roads have been classified using a Road Use Hierarchy, operational issues can be identified based on the current performance of the road network (using a multi-modal Level of Service framework). Then various solutions to these issues can be identified and tested using a Network Fit Assessment program. For a complete description of the SmartRoads framework, see VicRoads (2011).

VicRoads is the principal user of the SmartRoads program, with input and consultation from Transport for Victoria, public transport operators, local councils and other groups. Some jurisdictions outside Victoria, including South Australia, Queensland and New Zealand, have also begun to implement NOP frameworks based on the SmartRoads system.

1.2. Aims of the Research

The research aims to answer the key research question, '*What are the key factors that constrained and facilitated the implementation of SmartRoads?'* In doing so, we aim to identify the following:

- The key benefits of SmartRoads
- The barriers that constrain the implementation of SmartRoads
- The factors that facilitate the implementation of SmartRoads

The findings of the research provide road and transport authorities with an understanding of how to smooth the implementation of such frameworks.

2. Literature Review & Theoretical Development

In order to address the key research question, we develop a theoretical model based on the literature, which will assist in explaining how certain factors constrain and facilitate the implementation of frameworks such as SmartRoads.

The theory of implementation within the public policy literature can provide some basis for discussion of the factors that may constrain and facilitate implementation of the SmartRoads framework by VicRoads. Implementation Theory considers the implementation of projects, policies, etc., from the perspective of the organisation (Elmore 1978, Gunn 1978, Sabatier 1986, Sabatier 1998). However, in the case of the implementation of the SmartRoads framework, VicRoads must gain buy-in and be endorsed by both its internal and external stakeholders. A stakeholder is an entity (e.g., employee, customer, partner, etc.) with a stake in another organisation, where it is affected by, or has influence over, that organisation (Blowfield and Murray 2008). VicRoads' internal stakeholders include the various organisational departments within VicRoads and their staff, while external stakeholders include the Victorian State Government, local municipal councils, public transport companies, road users, etc.

The concept of legitimacy, which stems from Institutional Theory (Scott 1995, Tolbert and Zucker 1996, Scott 2001), provides the basis for developing a conceptual framework for the current study, as it allows for both organisational- and external stakeholder-level perspectives. Legitimacy Theory assumes that organisations feel obliged to create additional value for society because they have been given the right to operate (Johnson 2004, Tilling 2004). Therefore, certain systems of norms, values, beliefs and definitions, established within a society, define what type of corporate behaviour is legitimate (Suchman 1995).

2.1. Factors required to facilitate institutional legitimacy

Since VicRoads requires buy-in from both internal and external stakeholders for the implementation of SmartRoads, it seeks legitimisation at the institutional, organisational and external stakeholder levels. The literature suggests three key factors (based on different theories) which can facilitate the legitimisation of SmartRoads at these three levels.

First, at the institutional level, **endorsement** is a key factor at legitimising an organisation's mandate. Endorsement demonstrates the formal support and approval from social actors such as customers, partners or governments (Stinchcombe 1968, Meyer and Scott 1983, Singh et al. 1986, Ashforth and Gibbs 1990, Baum and Oliver 1991). This endorsement can come in a range of forms, such as a legislated mandate, formal links to other organisations or customer buy-in (Ashforth and Gibbs 1990, Baum and Oliver 1991). For the case of implementing SmartRoads, government endorsement was deemed to be particularly relevant.

Second, at the organisational level, developing and implementing projects is full of complexities and a significant factor in the success of many projects is the **project champion** (Schön 1967). Both empirical research and anecdotal evidence have long supported the importance of the organisational champion for successful project implementation (Chakrabarti 1974, Maidique 1980, Peters and Austin 1985, Meredith 1986). A champion is an individual within the organisation who has been given the responsibility for implementing a project or initiative. Champions possess certain attributes that make them suitable for the role, which often requires a creative and entrepreneurial approach, as opposed to handling the

typical routine aspects of project development and implementation. That is, champions possess an "enthusiasm and fervor" for their project (Covin and Slevin 1988) and "tend to be visionaries, cheerleaders, and risk-takers" (Pinto and Slevin 1989). Champions are particularly important in supporting new innovations and technologies (Littler and Sweeting 1985, Howell and Higgins 1990, Beatty and Gordon 1991).

Finally, at the external level, **stakeholder engagement** is key to gaining legitimacy from external actors. Stakeholder engagement refers to the participation, partnership and involvement of stakeholders both internal and external to the organisation. According to Suchman (1995), the maintenance and management of legitimacy requires interactions with stakeholders. Furthermore, according to the Stakeholder Theory, organisations exist to create and provide value to their stakeholders, but this depends on the support and cooperation of these stakeholders (Freeman 1984, Freeman and Velamuri 2006).

Considering how these functions which can facilitate implementation of the SmartRoads framework, we propose a theoretical framework based primarily on the concept of legitimacy from Institutional Theory. The framework applies to the processes of establishment and maintenance of legitimacy. Figure 1 illustrates the proposed theoretical framework.

Figure 1: Factors necessary to facilitate the implementation of the SmartRoads framework

3. Methodological Approach & Analysis

We undertook a multiple-case study design approach to document feedback about the implementation of SmartRoads. Our case study analysis draws on the experience of some of the key stakeholders in the road traffic network, which is managed by Transport for Victoria. This required collecting data about: the benefits of SmartRoads; constraints to the implementation of SmartRoads; and factors that facilitate the implementation of SmartRoads.

The primary data for the case study analysis was sourced by conducting interviews with 11 stakeholder groups in 10 organisations. These stakeholders included municipal 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. 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.

4. Analysis & Findings

The most dominant themes related 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 revealed that there are some solutions being applied to reduce the constraints to the implementation of SmartRoads. These common themes are discussed as follows.

4.1. The Benefits of SmartRoads

The case study analysis revealed two key benefits from the implementation of SmartRoads. These are discussed below.

4.1.1. 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 (Sabatier 1998), a 'policy broker' brings together these coalitions and acts as an impartial mediator that seeks reasonable compromise between the coalitions.

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. SmartRoads has become a tool to use for 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 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.

4.1.2. 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 Road User Hierarchy, 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 Road Use Hierarchy, they had something solid to follow. Therefore, SmartRoads allows VicRoads staff to see if proposed changes align with VicRoads' objectives because it can show engineers exactly how much of an impact such

changes would have, i.e., in terms of gap in Level of Service (LOS) as determined by the Network Fit Assessment.

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. They could estimate the level of impact of projects on the traffic network. That is, SmartRoads provides guidance to engineers.

4.2. Barriers that constrain the implementation of SmartRoads

The case study analysis identified several types of constraints that impacted the implementation of SmartRoads. They can be categorised into principles-related, VicRoads-related and technical constraints. Principles-related constraints refer to the issues that stem from the Road Use Hierarchy. Internal constraints refer to those which are faced internally by VicRoads. Finally, technical constraints refer to those related to technical issues faced in the use of SmartRoads. Some of the key constraints are discussed as follows:

4.2.1. Principles-related constraints

The principle of the Road User Hierarchy is to explicitly trade-off the demands of different modes across different parts of the road network. As mentioned, one of the primary benefits of SmartRoads is that, through the Road User Hierarchy, VicRoads can act as a 'policy broker' during this process. Although this process reduces conflict, it does not eliminate it entirely.

For example, some external stakeholders believed that VicRoads was not sufficiently managing conflict between stakeholders, particularly between public transport operators. Others pointed out that not all mode user groups were always present at workshops; for example, there may not have been a representative of cyclists present to advocate for cycling priority.

4.2.2. Internal constraints

Two constraints internal to VicRoads slowed the implementation of SmartRoads over the ten years of its development. The first was a change-resistant internal culture and the second was a series of internal restructures.

The bureaucratic process model assumes that the dominant characteristic of organisations is resistance to change (Elmore, 1978). The present study provides evidence of a change-resisting internal culture at VicRoads, which has constrained the efficient and effective implementation of SmartRoads.

For example, one external stakeholder acknowledged that VicRoads has matured enormously in changing its objectives from moving 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.

Another external stakeholder claims that there were some within VicRoads, the "resistors", who were not willing to consider that arterial roads should be used for anything other than moving cars. Within VicRoads, it was acknowledged that this attitude varied across the organisation with more "resistors" holding out in regional offices.

Furthermore, like many organisations VicRoads has faced a number of internal restructures over the years. After an initial period of development, the core SmartRoads team was disbanded and spread across the organisation. Former SmartRoads team members were still able to provide support for projects. However, it soon became clear that this distributed approach was not enough to support the use of SmartRoads and implementation slowed down. Since then, a central 'SmartRoads' team has been re-established which helped fully embed SmartRoads into organisational practice.

4.2.3. Technical constraints

SmartRoads requires both technically skilled users and large amounts of data. The SmartRoads application is not user-friendly and has been described by some external stakeholders as "clunky" and inaccessible. It also requires a large amount of data, including traffic flows Level of Service ratings for all modes on all road segments in the network. Estimating changes to Level of Service based on proposed network solutions cannot be done automatically; these estimates must be done outside of the Network Fit Assessment software and inputted manually.

Because of these constraints, conducting a Network Fit Assessment (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. 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. This means that few organisations outside VicRoads can perform their own Network Fit Assessments. Any time the stakeholder requires some information that SmartRoads can calculate, it is done by VicRoads.

4.3 Addressing Constraints to Implementation of SmartRoads

The research team's interviews with the various internal VicRoads and external stakeholders of SmartRoads have revealed evidence that there are some solutions being applied to reduce the constraints to the implementation of SmartRoads. The principles-related constraints can never be fully overcome (as there will always be conflicts over which modes should be given priority within limited road space). However, two key developments are occurring to address the internal VicRoads constraints and the technical constraints.

4.3.1. Addressing VicRoads' internal culture

According to the VicRoads team, early on it was difficult to gather internal support for SmartRoads 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 framework. 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, being more involved in the process played a significant role in shifting the views of many people within VicRoads over time.

4.3.2. Addressing the high resource requirements of SmartRoads

VicRoads has continued to provide training for consultants and councils who are interested in learning how to use the Network Fit Assessment software. This helps to overcome the issue of the technical knowledge requirement of SmartRoads.

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. 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.

Furthermore, after this research was conducted it was announced that a new incarnation of SmartRoads is now under development within VicRoads (the 'Movement and Place' framework). This includes a much-simplified process of Network Fit Assessment, which should further reduce the technical knowledge required to use the tool.

4.4. Factors that facilitated the implementation of SmartRoads

The previous sections discussed specific constraints to implementing SmartRoads. Yet it can be comfortably stated that over time, SmartRoads has been successfully embedded in the organisation. A number of factors helped to facilitate this process, drawing largely from the three requirements discussed in the literature review: government endorsement, championing and stakeholder engagement.

4.4.1. Government endorsement

The implementation of SmartRoads was supported by the early and sustained endorsement of the state government.

At the same time that SmartRoads was under initial development, it so happened that 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 (Parliament of Victoria 2010). 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" (Parliament of Victoria 2010). 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.

Somewhat fortuitously, VicRoads was already developing the SmartRoads framework at the time. This meant that the ratification of the Transport Integration Act gave immediate legitimacy to VicRoads' early implementation of SmartRoads. VicRoads teams mentioned that because of the SmartRoads framework, around 80% of the Transport Integration Act mandates were already being considered.

4.3.2. Championing

Drawing on 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 (Director of Integration Services at VicRoads) was the first champion of the SmartRoads framework. Although his role within VicRoads has changed over the years, in every role he has directly or indirectly acted as a champion for the SmartRoads framework. He has also 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. Yet without the continued support of Andrew Wall, it is unlikely that SmartRoads would have been implemented fully (if at all).

4.3.3. Extensive stakeholder consultation

From its inception, SmartRoads was developed and applied through extensive consultation with stakeholders. It involved engaging with 31 municipal councils and other stakeholders such as RACV, Bicycle Network Victoria, PTV and public transport operators. This consultation continues in the form of workshops whenever new projects are proposed or route reviews are conducted on existing corridors.

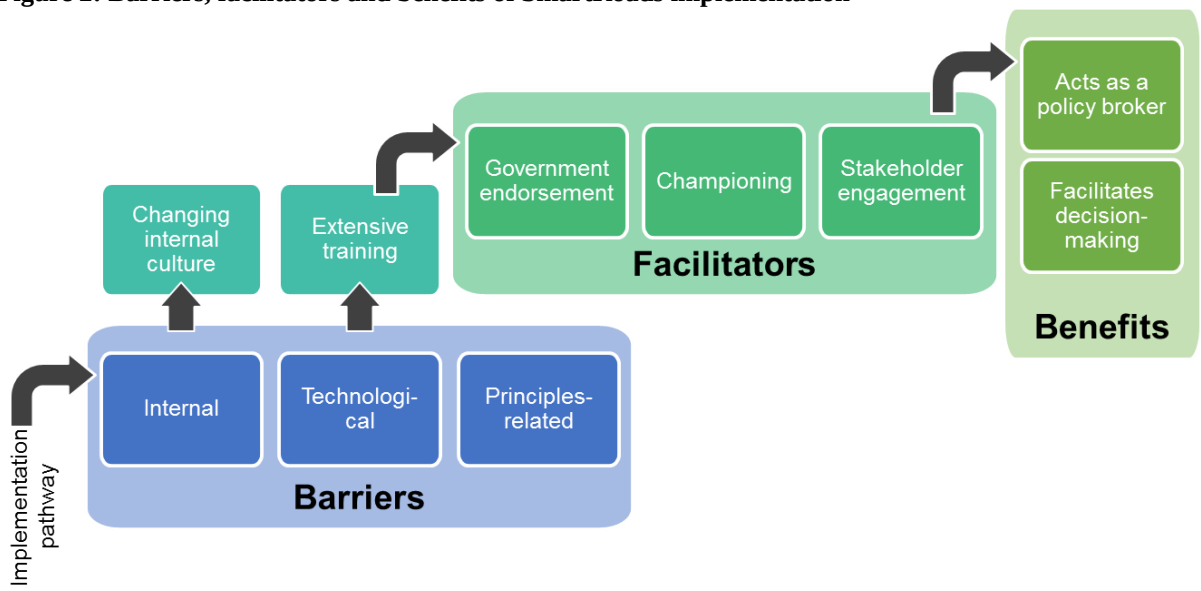
VicRoads has been able to implement SmartRoads across the road network in Victoria because of support and endorsement from the local municipal council mayors who agreed on the Road Use Hierarchy for their jurisdictions. There are only two councils in the Melbourne metropolitan region that have not endorsed SmartRoads because of disagreements over the Road User Hierarchy in their council.

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.

5. Summary of findings

The aim of this project was to identify the key factors that constrained and facilitated the implementation of SmartRoads. Figure 2 summarises these barriers and facilitators which shaped the implementation pathway of SmartRoads. Internal, technological and principles-related barriers hampered the implementation of SmartRoads (and continue to some extent). Yet changes to internal culture and extensive training have helped to overcome these barriers.

Figure 2: Barriers, facilitators and benefits of SmartRoads implementation



At the same time, the study identified three key facilitators that played a central role in the implementation of the SmartRoads framework: government endorsement, championing and stakeholder engagement. While stakeholder engagement facilitates the implementation of the

SmartRoads framework, it itself is facilitated by both government endorsement at the institutional level and championing at the organisational level. Both these factors encourage the buy-in of other stakeholders, both internal and external to the implementing organisation. These findings align with our theoretical framework in which implementation requires legitimacy gained by these three factors.

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. SmartRoads is now delivering its key benefits as a policy broker balancing the often-competing needs of different road users, and smoothing the process of operational network planning.

6. Advice for jurisdictions implementing Operations Planning Frameworks

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:

6.1. 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.

6.2 High initial resource requirements

Setting up a Road User Hierarchy and Network Fit Assessment is a resource- and time-intensive activity. VicRoads provides the Network Fit Assessment 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.

6.3 Genuine stakeholder 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 Network Fit Assessment process works.

7. Conclusions

The Transport Integration Act mandates that VicRoads give consideration to all factors when considering changes to the road network, including priorities for various modes and considering how those changes impact places. The development and implementation of the SmartRoads framework has helped VicRoads to deliver its objectives to the Victorian government, such as when making changes to the road traffic network.

Despite the identified constraints to the implementation of SmartRoads, if the mentioned solutions and others that are planned for the future are implemented, then 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.

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 working relationships 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 the SmartRoads 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.

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