Traffic incident management: framework and contemporary practices

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Abstract

A framework has been developed to present many aspects of traffic incident management (TIM) with an aim to harmonise incident management approaches in Australasia. By providing road network managers and incident management service providers with a guidance and common understanding of the ongoing process for integrating TIM practices and techniques, traffic disruption and road safety risk can be managed in a more co-ordinated and effective manner.

Based on the Austroads research report (AP-R547-17), this paper presents the TIM framework and underlying principles for the various incident management phases from multi-agency collaboration and planning to performance evaluation and capability development. The outcome of identifying contemporary TIM practices from a review of jurisdictional policy and procedure documentation is discussed to support the overarching goal of the framework in maintaining mobility and improving safety during an incident.

Key words: incident management, traffic incident management, traffic management
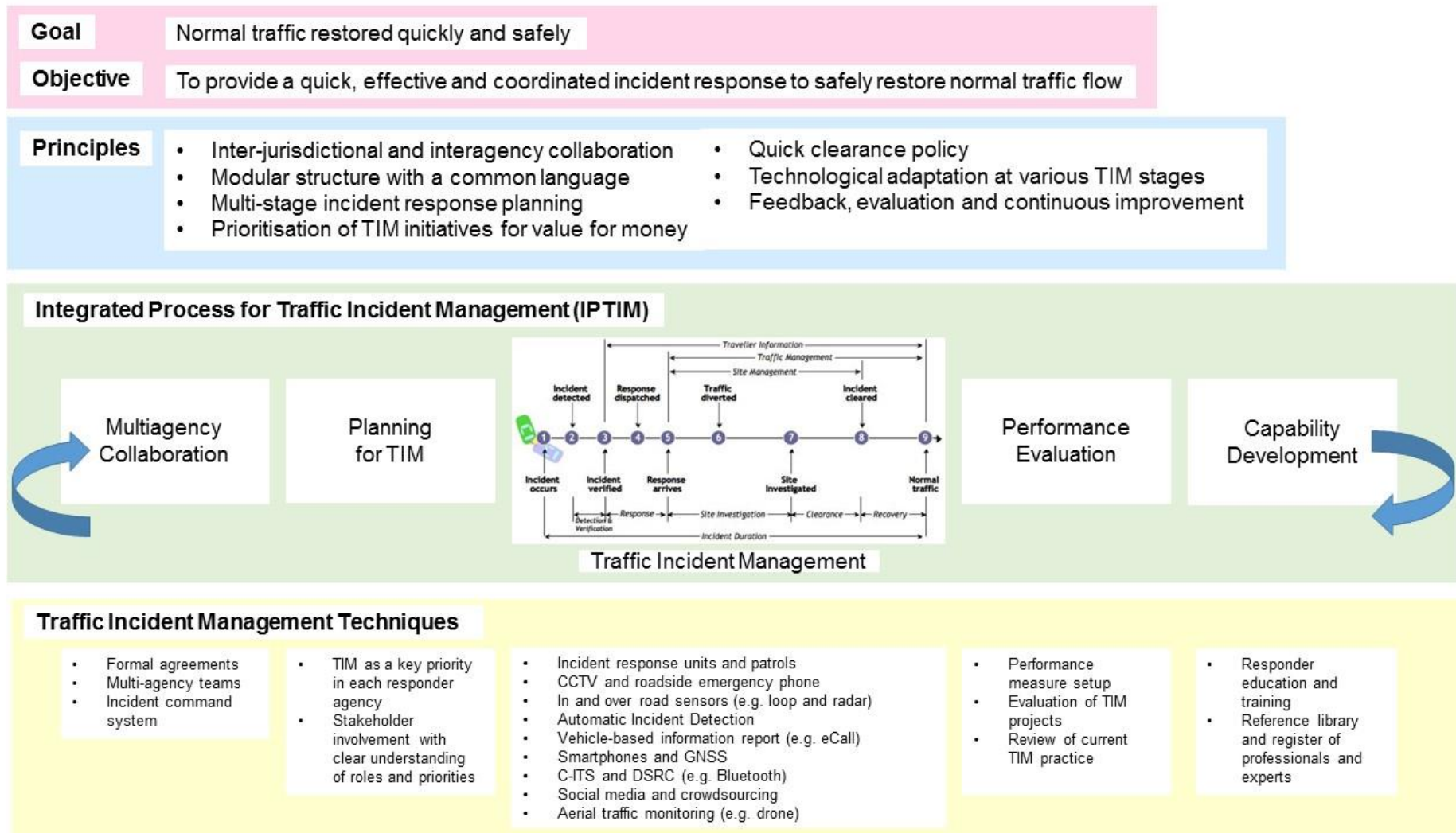
1. Introduction

The lack of a harmonised incident management framework across Austroads member organisation has been identified by Austroads as a gap in the TIM knowledge. A research project was initiated and undertaken to develop an agreed incident management framework by reviewing the literature on the TIM topic as well as current incident management practices and techniques in Australia and New Zealand (Austroads 2017). The findings of the review of the contemporary practices in the context of the TIM framework is the focus of this paper.

2. Traffic incident management framework

As show in Figure 1, the TIM framework incorporates the goal and objective of resuming normal traffic flow quickly and safely in an effective and coordinated manner. The framework is underpinned by seven management principles and five phrases of managing TIM activities. Example of TIM techniques at each phase within the Integrated Process for Traffic Incident Management (IPTIM) are also included.

The IPTIM is an interactive process, incorporating key management stages as discussed in the best practice report (Austroads 2007e). The multi-agency collaboration phase is a critically important first step in the framework as it establishes a relationship and interaction among the jurisdictions and the various agencies (police, transport agency, fire and rescue, medical emergency and towing and recovery) and stakeholders (media and user groups) to support one another. A formal agreement is required to guide the development of a modular team structure with common objectives and language, clear command hierarchy and designated responder roles and responsibilities.

Figure 1: Traffic incident management framework

Goal — Normal traffic restored quickly and safely

Objective — To provide a quick, effective and coordinated incident response to safely restore normal traffic flow

Principles
- Inter-jurisdictional and interagency collaboration
- Modular structure with a common language
- Multi-stage incident response planning
- Prioritisation of TIM initiatives for value for money
- Quick clearance policy
- Technological adaptation at various TIM stages
- Feedback, evaluation and continuous improvement

Integrated Process for Traffic Incident Management (IPTIM)

Multiagency Collaboration → Planning for TIM → Traffic Incident Management → Performance Evaluation → Capability Development

Traffic Incident Management Techniques

- Formal agreements
- Multi-agency teams
- Incident command system

- TIM as a key priority in each responder agency
- Stakeholder involvement with clear understanding of roles and priorities

- Incident response units and patrols
- CCTV and roadside emergency phone
- In and over road sensors (e.g. loop and radar)
- Automatic Incident Detection
- Vehicle-based information report (e.g. eCall)
- Smartphones and GNSS
- C-ITS and DSRC (e.g. Bluetooth)
- Social media and crowdsourcing
- Aerial traffic monitoring (e.g. drone)

- Performance measure setup
- Evaluation of TIM projects
- Review of current TIM practice

- Responder education and training
- Reference library and register of professionals and experts

Source: Austroads (2017).

The second phase is the planning process. To improve the resource efficacy and deliver greater community benefits, it is imperative to plan incident response procedures and prioritise TIM programs and initiatives. Benefits can be realised by a wide range of means such as improved safety, reduced congestion and reliable incident-related information. A multi-stage planning for TIM can be instigated by identifying the needs and establishing desired objectives and outcomes at each TIM stage from incident detection to traffic recovery. A strategic framework and setting up performance measures should also be considered at the planning phase.

During the TIM stages, it is important to adapt new technologies and to automate procedures to enable quick and safe clearance. The application of technology (e.g. the use of Bluetooth technology and automatic incident detection algorithms to detect and verify incidents) can be observed in the findings of the literature and jurisdictional review. Performance evaluation and capability development are the last two phases of the IPTIM. They are essential for an ongoing process and procedural improvement, especially with the adaptation of advanced TIM technology.

3. Contemporary practices in Australasia

For each IPTIM phase, the contemporary leading practices have been identified from a review of current incident management practice in Australia and New Zealand. As demonstrated in the following sections, the incident management concepts and techniques at various planning and implementation stages documented in the Austroads best practice publication (Austroads 2007e) that built on the earlier project reports (Austroads 2007a-2007d) remains largely relevant in practice.

3.1. Multi-agency Collaboration

Effective traffic incident management operations require good inter-agency coordination and cooperation. Road traffic and transport agencies, the police, fire brigade and ambulance services are the primary organisations involved in traffic incident management in most jurisdictions across Australia and New Zealand. However, the roles and responsibilities of the responding agencies vary according to stakeholder and jurisdiction.

Setting up a formal agreement or MoU among responsible agencies can help in the achievement of more efficient management of traffic incidents. These agreements reduce the possibility of misunderstanding, disagreements, delays, and inefficiencies in resolving traffic incidents. In addition to highlighting the roles and responsibilities of different stakeholders the MoUs address desired joint outcomes, incident command structures, resource staging, traffic control, incidents involving hazardous materials and crash investigation procedures, quick clearance procedures. They can also set performance goals such as response time or incident clearance time.

In NSW, a MoU for the management of road and traffic incidents was signed in 2010 to highlight the roles of all participating agencies, incident management protocols, incident control systems and traffic management of incidents (Transport for NSW 2016). The MoU also identifies the priority roads at the time of any traffic related incident. The incident perimeters and responsibilities between participating agencies are illustrated in Figure 2.

Another example is a *MoU on Road Clearance* has been signed between Victoria Police and VicRoads (Victoria Government n.d.). This MoU states the procedures to be followed at the time of incident clearance. To clear the incident in a timely and compliant manner, it also states the requirement of a VicRoads Traffic Commander to be present at the incident site if there is no VicRoads officer present. After satisfactory completion of all statutory responsibilities, the most senior Victoria Police officer present at the incident site will hand over the site to the VicRoads Traffic Commander who takes responsibility for clearing the incident site. During this process, if required, Victoria Police may remain at the site. VicRoads bear the costs

associated with clearing the incident and, at its discretion, may instigate cost recovery measures against another party or parties.

Figure 2: Incident perimeters and responsibilities between participating agencies in NSW
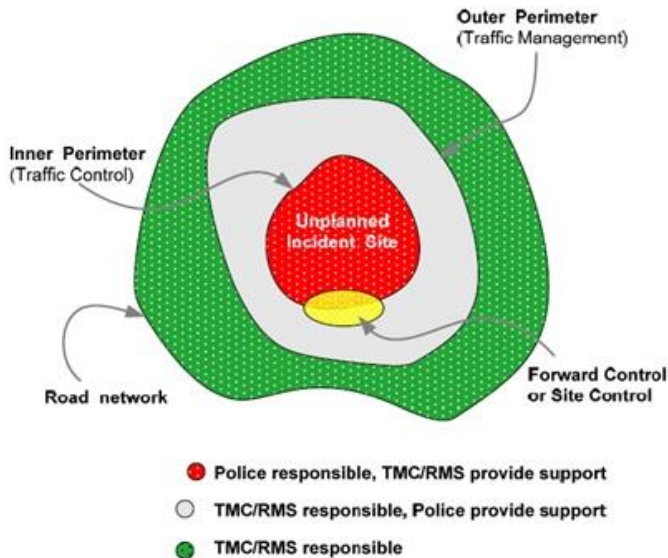
Source: Transport for New South Wales (2016).

Organised multi-agency incident management teams (IMTs) are a tool for achieving the established goals and objectives of the traffic incident management program. These teams are comprised of different representatives from different agencies and perform certain set of responsibilities. They deal with inter-agency cooperation, set the command and control hierarchy, traffic planning during an incident, the development and conduct of training components, policy issues and the organisation of post-incident briefings with the public and the media.

3.2. Planning for Traffic Incident Management

To ensure the most effective response in a timely manner, operational planning for potential traffic incident scenarios is an important step. This includes assigning the potential workload and planned response by different categories such as the location of the incident, the level of incident, time of day and day of week on critical traffic networks. This will enable an appropriate level of service to be achieved.

Most of the jurisdictions in Australia follow the current practice of planning for traffic incident management recommended by Austroads (2007e). It highlights the requirements of a planning team to progress the planning and management of incidents along with the development of agreed objectives and desired outcomes, and the understanding of the competing objectives of the various responders. It needs a clear understanding of each stakeholder's objectives and priorities.

In New Zealand, the Coordinated Incident Management System (CIMS) is used to establish the structure, roles and processes in managing traffic related incident response (NZ Government 2014). The fundamental elements of response structures, functions, processes, and common terminology are reported in the CIMS. With different operating procedural requirement, individual agencies can develop their own CIMS. There are five response levels in the CIMS: national, regional, local, incident and community. Most incidents require only the activation of one or two response levels. Generally large-scale incidents require all levels of

response to be activated. Moreover, CIMS can be scaled up or down to manage specific incident type or size. The decision to scale the response structure needs to be based on safety, size, complexity and span of control.

3.3. Traffic Incident Management

The TIM process can be characterised by incident management activities from detection and verification to site management and traffic clearance. Figure 3 illustrates the temporal development of a traffic incident from occurrence to return of normal traffic conditions (Austroads 2007e). The aim of these components is to provide a quick, effective and well-coordinated response in order to minimise the duration and impact of a traffic incident.

Figure 3: Traffic incident management steps
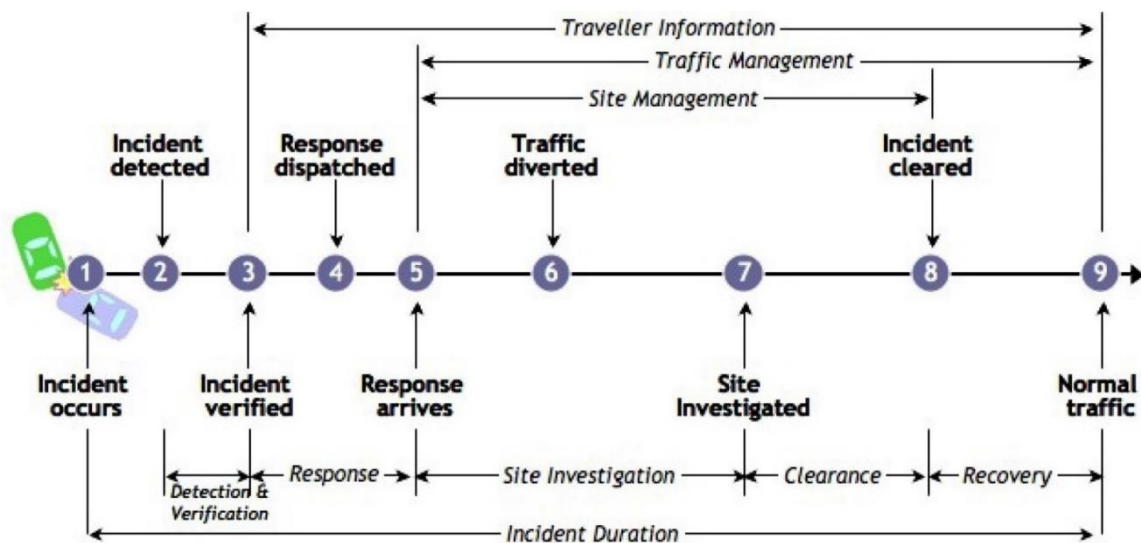
Source: Austroads (2007e).

The following sections discusses the contemporary practices in the key steps of incident detection and verification, incident response, traffic management and traveller information.

3.3.1 Incident Detection and Verification

Incident detection or being notified about a traffic incident is the very first action in incident management. Most of the jurisdictions across Australia and New Zealand have adopted different technologies to detect and verify incidents in transport networks. Some commonly used incident detection and verification technologies are CCTV, Automatic Incident Detection (e.g., Addinsight, SCATS, STREAMS) and iSentry. Most of the jurisdictions rely heavily on field units to verify an incident. There are a range of other technologies available for traffic management which are also used to detect incidents such as pneumatic tubes, microwave radar, video image detection, vehicle probes, Bluetooth and mobile phone location..

In early 2012, the Department of Planning, Transport and Infrastructure (DPTI) undertook a comprehensive survey of network travel times utilising Bluetooth technology. This project was so successful that DPTI have developed a product called *Addinsight* based on the technology utilised during the survey. Later, using the same working principle, a smartphone app was developed. This app uses a network of more than 700 Bluetooth receivers to generate real-time travel times and identify delays and congestion. The data is then provided back to the driver in the form of spoken alerts, giving the driver advanced warning of the location of delays

and how many minutes of travel time those delays are expected to cause. This allows motorists to divert to another route to avoid the delay.

The original purpose of this system was to estimate travel times across the transport network in real time; however, the system also assists in the identification of incidents as well as to monitor incidents and road works. A dedicated 'map view' has been developed within this system to identify the incident in the network since sometimes it is not possible to identify the incident from a congested link alone. Out of all the options considered by the DPTI, Bluetooth technology appeared to be the most cost-effective; the receivers continuously analyse travel time data, identify the incidents for over 2000 road segments that covers nearly 900 km of the arterial road network in South Australia (Cox n.d.). *Addinsight* also has the ability to provide customised messages in response to an incident. These messages come straight from the TMC and can be up to 200 characters in length, which allows it to provide considerably more information than a VMS.

The app is currently being trialled by seven other road authorities within Australia and New Zealand. Recently, the *Addinsight* system and smartphone app was recognised at the ITS Australia National Awards (Mullighan 2016).

3.3.2. Response to Traffic Incidents

To clear a traffic incident in a safe and timely manner, a proper response necessitates understanding of the incident location, nature and scope. An efficient response also requires the essential resources and high-level working procedures to clear an incident.

In most of the jurisdictions, response to traffic incidents is categorised according to the nature and severity of the incident. For example, Main Roads Western Australia (MRWA) has established three levels of incident severity and categorised the actions required by different stakeholders, people involved in the incident, environment of the incident and resources required for each incident level. Once the level of incident has been identified the next step is the activation of a suitable incident management plan and deployment of appropriate resources to the incident site. At this stage the incident is monitored closely for possible escalation in accordance with MRWA policy.

Austroads (2007e) has proposed a 'five-level' incident classification depending on the expected duration and the nature of the incident. Table 1 shows a comprehensive classification of incidents to assist in appropriate and fast responses.

Another key factor that facilitates a prompt response is effective and well-synchronised communication between responder agencies. This includes compatible communications systems and mutually-understood definitions, jargon and descriptions of processes and technologies. By conducting inter-agency training exercises on a regular basis, a mutually-acceptable response procedure can be established.

To respond to an incident more quickly, Queensland Department of Transport and Main Roads (QDTMR) is actively rolling out an emergency vehicle priority (EVP) system across Queensland. Emergency vehicles such as ambulances and fire engines are fitted with technology to trigger traffic light sequences so that respondents can travel from their depot to an incident site as quickly and as safely as possible (QDTMR 2017). The EVP system uses a computer-aided dispatch, GPS and traffic management information to determine the location of the emergency vehicle and the predicted arrival time at the next set of traffic lights. Once the emergency vehicle has passed, the traffic lights will return to a normal operation, minimising traffic disruptions.

Table 1: Incident types and classification

	Level 1	Level 2	Level 3	Level 4	Level 5
Type of incident	Vehicle on shoulder	Vehicle in lane	Minor crash (no injury) Minor debris	Injury crash Debris Fire	Major injury crash Hazmat Fires
Estimated Duration	Nil	0-30 minutes	30-60 mins	1-2 hours	>2 hours
Response	TRU/tow	TRU/tow Traffic control	Police Traffic control Tow Clean up	Police Fire Medical Traffic control Tow Clean up	Police Fire Medical Hazmat Traffic control Tow Clean up

Source: Austroads (2007e).

3.3.3 Traffic Management

Traffic management encompasses the application of traffic control measures in areas affected by an incident in order to minimise traffic disruption while maintaining a safe workplace for responders (Austroads 2007e). To manage road traffic during incident response, most of the jurisdictions practice some combination of the following procedures depending on the level of response required:

▪ establishing point traffic control on-scene

▪ filtering traffic past the incident scene

▪ detouring traffic onto an alternative route

▪ contra-flow management

▪ end-of-queue management

▪ managing the roadway space (e.g. opening and closing lanes, blocking only that portion of the incident scene that is needed for safety, staging and parking emergency vehicles and equipment to minimise impact on traffic flow)

▪ deploying appropriate personnel to assist in traffic management

▪ actively managing traffic control devices including traffic signals and designating developing, and operating alternate routes.

Traffic management procedures also vary based on the type of road (e.g. local road, arterial, motorway), type of diversion route (e.g., sign-posted and non-sign posted), and the weight and size of vehicles (e.g. heavy vehicles and over dimensioned loads).

Collaboration with emergency services and other key stakeholders can facilitate effective traffic management and provide a better service to road users and the entire road network. As recommended by Austroads, traffic management centres need to coordinate incident

notification and response, and each stakeholder should train all responders in efficient traffic management.

In Western Australia, a MoU has been signed by MRWA and WAPOL in relation to the use of laser scanning survey equipment to achieve quicker clearance during an incident. WAPOL can use the laser scanning survey equipment to quickly capture a permanent three-dimensional (3D), 360 degree visual record of the accident scene in great detail. For insurance purposes or for possible police investigations, this use of this equipment is becoming more common around the world as a way of providing a much safer, more flexible and faster way to complete traffic investigations and reduce the impact on traffic flow. WAPOL shares its Computer Aided Dispatch (CAD) real-time information with MRWA in terms of any road hazard which may result in severe congestion and have an impact on emergency vehicles.

3.3.4. Traveller Information

Most of the jurisdictions use VMS, radio broadcasts, internet or online services, smartphone applications and telephone information systems to disseminate incident-related information to affected motorists. There is an opportunity to improve traveller information dissemination by extracting real-time incident-related information from social media and route planning application from third parties (e.g. Google, Tomtom and HERE). Data fusion and analytics are important in combining data and information from multiple sources.

It should be noted that some motorists may use third-party sources such as Google Maps and Apple Maps for navigation and for obtaining traffic information. These third-party providers disseminate traffic information based on historical travel time on a selected route. Very rarely do these vendors provide raw data and it is almost always processed in some way. This can lead to uncertainty and hide insights. Also, it is not possible to infer traffic volume (AADT and similar measures) from travel time or speed data with any reliability (Caceres, Wideberg & Benitez 2008).

If transportation agencies develop a navigation app for their jurisdiction, they can potentially provide real-time incident-related information to its motorists. Moreover, agencies would have control of the complete data collection and processing system and would not be dependent on a third-party supplier (e.g. SUNA Traffic). This is the path that South Australia has taken, through its *Addinsight* system, which includes a complementary smartphone app. While providing the public with real-time congestion information, the *Addinsight* system provides the traffic management centre with raw traffic data from about 15% of the traffic using the network.

3.4. Performance Evaluation

Performance evaluation is one of the key factors in any type of incident management practice. Performance evaluation guides the investigation of investment options, helps to determine policies, and assists to estimate the return on investment and assess options. In addition, it can assist in the evaluation of performance by monitoring and reviewing performance by measuring achievements against objectives. Many agencies evaluate their in-house performance every year using key performance indicators, benchmarking and reporting parameters.

In order to measure the efficiency of the overall incident management process, transport agencies largely collect information about all aspects of traffic incidents such as the arrival and departure times of all response services to measure TIM performance. On the other hand, emergency services agencies generally only collect information related to their agency (Austroads 2007e). A performance measurement framework that can be considered as best practice and is outlined in Table 2.

Table 2: Performance measurement framework

Item	Input	Process	Output
Incident Management	Detection and verification	Response, performance evaluation and review	Minimise traffic delays; maintain safety
Potential measures	number of incidents (by category: major, intermediate, minor) time to detect, verify	response time of responders response time (detection to activation) number of traffic diversions time to clear incidents duration of incidents number of responses to enquiries lane-loss time relationships with responders major incident debrief/audit	delays due to incidents secondary incidents customer satisfaction (complaints, media reports)

Source: Austroads (2007e).

3.5. Capability Development

To improve the quality of working practice among traffic incident management professionals, a number of areas of capability development can be considered. According to Austroads (2007e), capabilities can be improved firstly within individual agencies and secondly across multiple agencies, at both the strategic and operational levels.

Various state and local transport agencies provide in-house courses plus some inter-agency desktop and field training. These types of training activities solely focus on the usage of software tools and equipment used for incident management. However, there are very limited opportunities for training courses in the area of traffic incident management in educational or transport agencies across Australia and New Zealand.

Microscopic simulation modelling is an effective tool to show how an incident develops over time across a transport network. Different types of training, such as intensive short courses run at regular intervals, in-house training run by agencies, or training run by universities or other training providers would be beneficial for traffic incident management professionals.

Skills and capabilities of the professionals can be developed by other means which are highlighted in Austroads (2007e), including:

▪ having access to a network of professionals, thus enabling quick and ready access to the combined pool of experience and skills, and to seek advice from peers

▪ attending seminars and conferences, both in Australia and internationally

▪ undertaking desktop reviews, study tours or benchmarking activities, both nationally and internationally.

Capability development towards technological advancements should be given greater priority as the inclusion of technology in various TIM stages is increasing rapidly. Establishing a reference library containing all relevant manuals, guidelines, reports, and web links associated with leading technological practices would be beneficial in this regard.

4. Conclusion

This paper has discussed incident management practices in Australia and New Zealand within the Integrated Process for Traffic Incident Management (IPTIM). Consisting of the five management phrases, the iterative IPTIM of the TIM framework is instrumental in establishing an on-going improvement process, and enabling a harmonised incident management methodology across Australasia. The real-world examples of the contemporary practices have been included in the discussion in order to demonstrate the leading practices and techniques in achieving the incident management goal of restoring normal traffic quickly and safety in a coordinated manner.

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