

## **An operator-centred investigation of safety issues for emergency responders at traffic incidents.**

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### **Abstract**

Road crashes killed 1.24 million people across the globe in 2010 and it is estimated that between 14% and 17% of such crashes were secondary incidents – incidents resulting from an initial incident. One means of reducing secondary incidents is through effective traffic incident management. A major concern is that emergency responders pay a high price for their role in this important work as they make up a significant portion of those killed or injured in secondary incidents. The present study investigated responder perspectives about safety issues at traffic incidents. 720 emergency responders from Queensland Police Force, Queensland Fire and Rescue Service and RACQ's Traffic Response Unit participated in an online survey. Analyses used quantitative and thematic grouping of qualitative data to establish the most salient safety issues. Results across organisations indicate that the key factors for feeling unsafe at traffic incidents are vehicle and perimeter lighting, signage, procedures and protocols, and communication between organisations. There were, however, significant differences between organisations regarding their perspectives on safety issues at incidents. This work is part of an ongoing program of research about safety issues for emergency responders at traffic incidents; it has the potential to inform policy and practices across Australia and internationally.

### **Introduction**

Being killed in a road crash ranks as the tenth most likely way to die across the globe. In 2010, 1.24 million people died in an on-road crash (W.H.O. 2013). With every on-road incident, there is a chance of secondary incidents - incidents that occur as a direct result of the initial incident, and these can be fatal too. In the U.S. it is estimated that between 14-18% of all incidents are secondary in nature (Carson, 2010).

Emergency responders working at the scene of traffic incidents make up a sizeable percentage of the people killed and injured in secondary incidents. In the U.S. an average of one police officer per month is killed in roadside crashes (Fishcher, Krzmarzick, Menon and Shankwitz, 2012). In 2005, of the 98 fire fighters killed on U.S. roads, a quarter were performing their duties at emergency scenes (FSC, 2012). In Queensland, Australia, between 2005 and 2009 there were three fatalities and 145 injuries incurred by traffic controllers who were road/railway workers or police (DTMR, 2013).

Reducing the occurrence of such secondary incidents is a part of the road safety solution. As a result, there is an increasing focus on traffic incident management (TIM). TIM involves the coordinated

response from emergency services, traffic agencies and local government agencies to remove incidents and restore traffic capacity safely and efficiently (Charles, 2007; Farradyne, 2000).

Injuries and fatalities to responders at incidents often occur when a motorist does not adhere to the warnings and directions given around the outer cordon of an incident. One way to reduce the risks of secondary incidents at traffic incidents, therefore, is through affecting driver behaviour. At a traffic incident, the warning devices – lights, sirens, distinctive vehicles, markers and signs, are all aimed at keeping the scene safe, warning oncoming drivers of the hazards ahead and directing traffic past the incident or onto alternate routes. Establishing the optimal combination of warning devices at traffic incidents should therefore improve responder safety. There are numerous studies about the effectiveness of different warning devices and their combinations (e.g. Chan and Ng, 2009; De Lorenzo and Eilers, 1991; Flannagan et al., 2000; Gelasca et al., 2005; Ullman and Lewis, 1998; Wells, 2004).

However, in practice there are a number of other challenges for effective traffic control at an incident. Firstly, the workplace by its very nature is hazardous with vehicles travelling in close proximity at high speeds. All near misses and exposures have a high probability of resulting in serious injuries or fatalities if repeated, but in high risk workplaces risks can become normalised in workplace culture and their low frequency can make serious injuries and fatalities seem like random events and therefore uncontrollable (Russell, 2012). This can lead to organisational lethargy about the value of new safety measures.

A second factor is driver behaviour. Studies indicate that warning devices around traffic incidents are salient and should be detected by passing motorists even when optimal combinations for human perception are not used (Chan and Ng, 2009, Flannagan & Devonshire, 2007). There is also evidence to suggest that emergency responder warning devices are recognised by motorists (Dunn and Tunnicliff, 2005, Ullman and Lewis, 1998). However inappropriate driver behaviours still occur. This is due to factors such as cognitive biases and other cognitive factors (Brown, 2005, Groeger, 2002, Langham, Hole, Edwards and O'Neil 2002, Uhr, 1959), Cognitive style (Lev, Hershkovitz and Yechiam, 2007), personality characteristics (e.g. Trimpop and Kircaldy, 1997; John and Srivastava, 1999), fatigue (Petridou and Moustaki, 2000), alcohol (Wells, 2004) and cultural factors (Petridou and Moustaki, 2000).

Thirdly, the different responder agencies have their own processes and protocols originating from their specific tasks and foci. In their paper comparing the cognitive compatibility of car drivers versus motorcyclists, Walker, Stanton and Salmon (2010) identified that mental representations of a situation are as important as the objective state. This can lead to different types of road users experiencing the same road in significantly different ways. In the same way, emergency responders from different organisations have very different functions at traffic incidents. It is therefore conceivable that they see incidents in ways that are incompatible with each other. The safety impacts of cognitive compatibility between agencies are that firstly, they may be inadvertently reducing the safety of responders from other organisations and secondly, safety solutions for one organisation may conflict with another organisation.

Finally, the physical environment is different at every incident and can reduce the safety of the traffic incident scene. For example, incidents over the crest of a hill or around a corner, low light conditions, high speed conditions, inclement weather, hazardous chemical spills.

Previous academic studies have identified optimal colours, flash rates, vehicle positions, and combinations of warning devices, and also aspects of driver behaviours that reduce the effectiveness of the cognitively salient warnings. These studies highlight specifics that are important in our understanding of constructing a safe incident scene. It is difficult to see how it all might fit together, however. In an attempt to understand how to optimise safety at traffic incident scenes, it might be more productive to investigate traffic incident management holistically to establish the main issues for responders at incidents and concentrate efforts on improving those.

## **An Operator-Focused Study**

Emergency responders working at the scene of incidents are best placed to describe issues with incident scene safety and this study explores their experiences to determine the main safety gaps in current traffic incident management practices.

### **Method**

Emergency responders from the Queensland Police Service (QPS), Queensland Fire and Rescue Service and Emergency Services (QFES), and RACQ's Traffic Response Unit (TRU) completed an online survey. The aim of the survey was to determine the most salient issues at traffic incidents for emergency responders overall and also within the different organisations.

#### *Participants*

720 participants completed the survey – 550 from QPS, 144 from QFES, 25 from TRU and one respondent did not list his/her organisation. Of the respondents, 118 identified as traffic specialists and the other 598 were operational officers with a more generalist role.

The majority of participants were male with a breakdown of 84% male and 16% female responses. Twenty-seven respondents were in the 18-25 year age-group, 143 were aged between 26 and 35 years, 272 participants were aged between 36 and 45 years, 218 participants were aged between 46 and 55 years, and 58 participants were over the age of 55.

One hundred and thirty-six participants had worked for their organisation between zero and two years, 179 respondents from three to five years, 171 respondents from six to ten years and 229 respondents had a length of service exceeding 10 years.

In terms of practical experience, officers from RACQ's traffic response unit attended 51 incidents per month, QPS officers on average attended 4 incidents per month and QFES officers attended on average 7 incidents per month.

#### *Survey Design*

The 29 question online survey was designed using an in-house survey tool created using LimeSurvey version 1.70RC1. The survey was divided into four parts. Part 1 – 'general information', aimed to establish demographic information. Part 2 – 'your worksite', established participant perceptions regarding

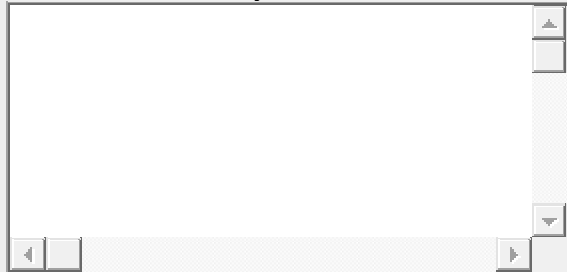
safety issues relating to their experiences working at traffic incidents. Part 3 – ‘specifics’, asked participants similar questions to part 2, but with a focus on what happened to them in the previous week. This section was added to check against part 2 to establish survey reliability. Part 4 – ‘Traffic Incident Management Program’ replicated the Austroads study from 2007 where Queensland scored lowest in the operational safety section of the study of traffic incident management in Australia. The section was not mandatory for respondents as the questions would be difficult to complete unless the respondents were in management positions.

Respondents answered a mixture of multiple choice and written questions. Below is a snapshot of the survey taken from the LimeSurvey tool.

**\* 10: Are there any issues with responder vehicle lighting at traffic incidents?**  
Please choose \*only one\* of the following:

none at all  
 very few issues  
 some issues  
 quite a few issues  
 many issues

Make a comment on your choice here:



### *Procedure*

The link to the survey tool was sent by email to the gatekeeper contacts from each of the three organisations and variations in procedures to obtain participants occurred within the organisations.

RACQ's TRU are a small unit of 36 traffic response officers. As a result all officers were asked to answer the survey after one of their shifts. They were given four weeks to complete the survey. The response rate of 25 out of the 36 officers (69%) was therefore comparatively high.

The Queensland Fire and Rescue service sent a broadcast email to 750 operational officers in the Brisbane region and 200 operational officers from other Queensland regions. The officers were given four weeks to respond to the email; however this included the Christmas period. The response rate for QFRS was 15.5%.

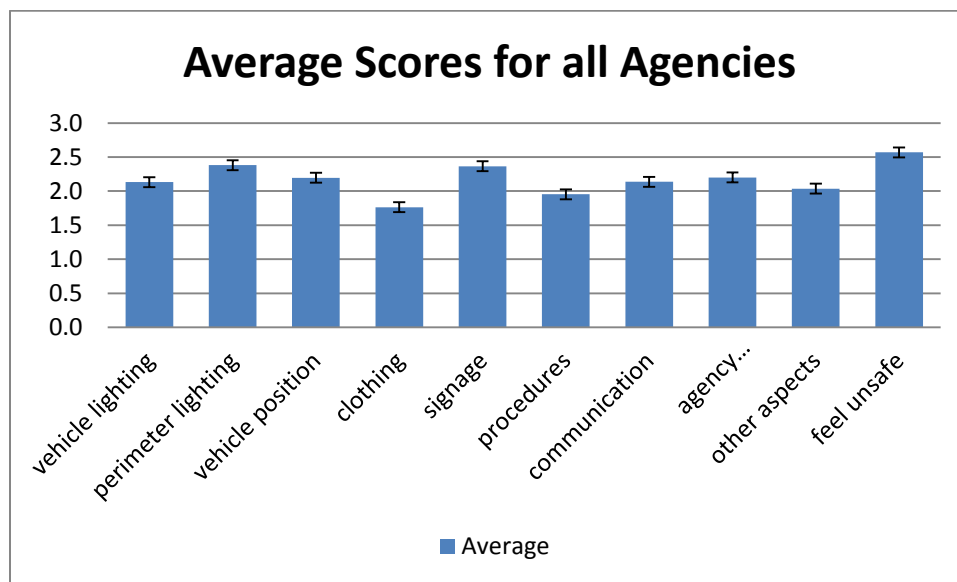
The Queensland Police Service sent a broadcast email to 10,667 officers. The email requested that operational officers complete the survey within a three week timeframe in January 2014. Of the 10,667

officers receiving the email, only a small percentage were operational, but it was impossible to isolate the group. The email informed officers only to respond if they were operational. Therefore despite the fact that the response rate for QPS was low at 5%, the figure is artificially low and is likely to be closer to the QFES response rate in reality. Data from the survey tool were initially exported to a Microsoft Excel 2010 application. The data were cleaned in Excel and then quantitative data were exported to IBM SPSS Statistics version 22 for further analysis. Qualitative data were initially analysed in Excel format and then exported to Leximancer version 4 for thematic and concept analysis of written responses.

## Results

### *Quantitative Results*

In figure 1 (below) the mean participant scores for the 10 safety issue questions in the survey are depicted across all organisations. The scores ranged between 1 and 5. Overall, the greatest safety concerns across agencies were feeling unsafe while working in traffic incident precincts (Mean = 2.6), perimeter lighting (Mean = 2.4) and signage (Mean = 2.4).



**Figure 1: Mean scores for safety issues at traffic incident precincts across organisations**

To identify the significance of safety issues within and across organisations, a series of ANOVAs were conducted. A 3 (organisations) x 10 (questions) factorial design was used to test for main effects of workplace and safety issues and for an interaction between workplace and perceived safety issues.

Perceived safety issues were significant beyond the .01 level  $F(9, 624)$ ,  $p < .01$  partial eta squared = .02.

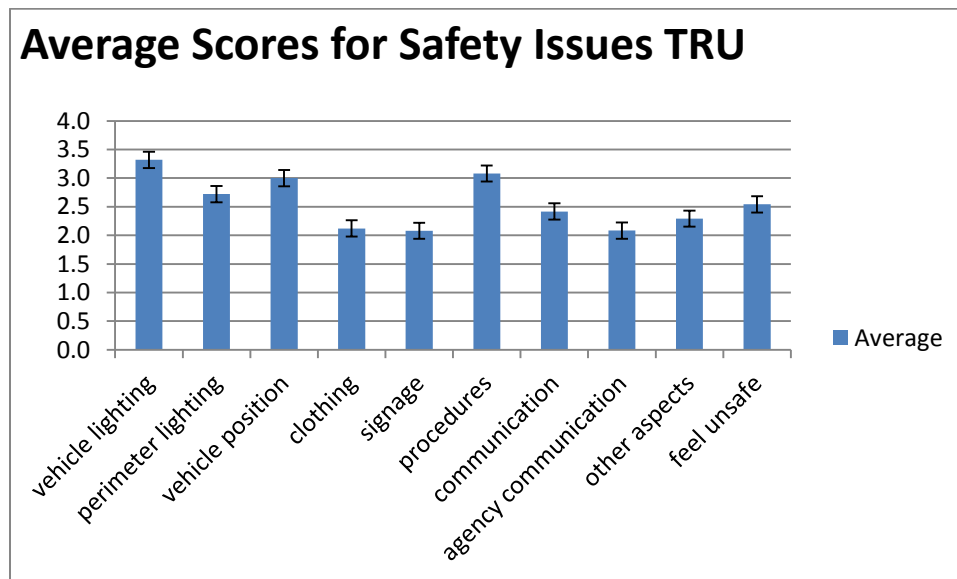
There was also a significant interaction between organisation and safety ratings  $F(18, 624) = 6.79$   $p < .01$  partial eta squared = .04. The significant difference between organisations in their ratings of issues indicates an investigation of organisational scores separately is warranted.

**Table 1: Test of within subjects effects**

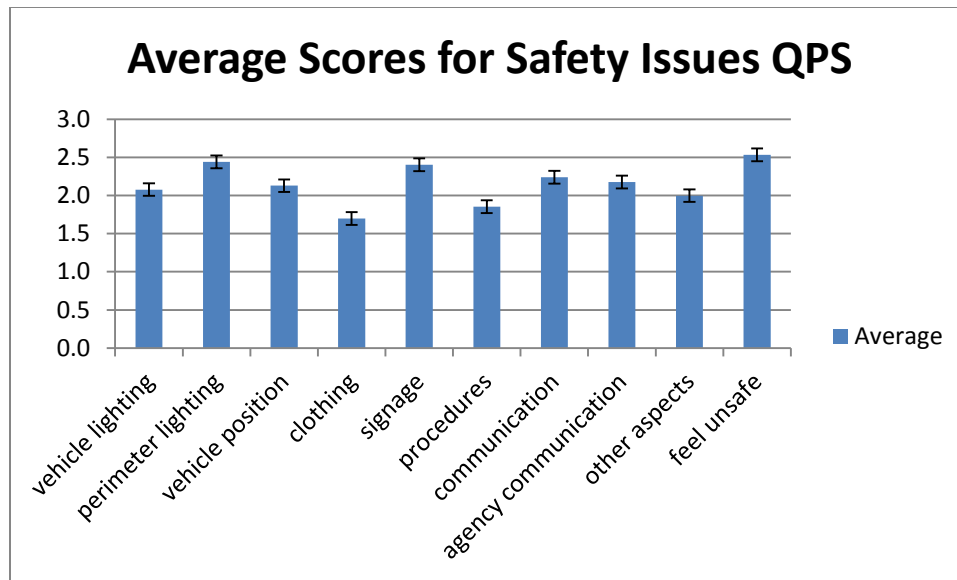
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Safety ratings	65.50	8.50	7.70	12.00	.00	.02
Safety ratings x Organisation	122.18	17.01	7.19	11.19	.00	.04
Error	3405.48	5305.83	.64			

The mean ratings for the different responder organisations differed significantly at the 1% level  $F(1,624) = 7.67$   $p < .01$  partial eta squared = .02. A Tukey test identified that differences were significant between RACQ and QPS  $p > .01$  and RACQ and QFES  $p > .01$ . However there was no significant difference in safety ratings between QPS and QFES.

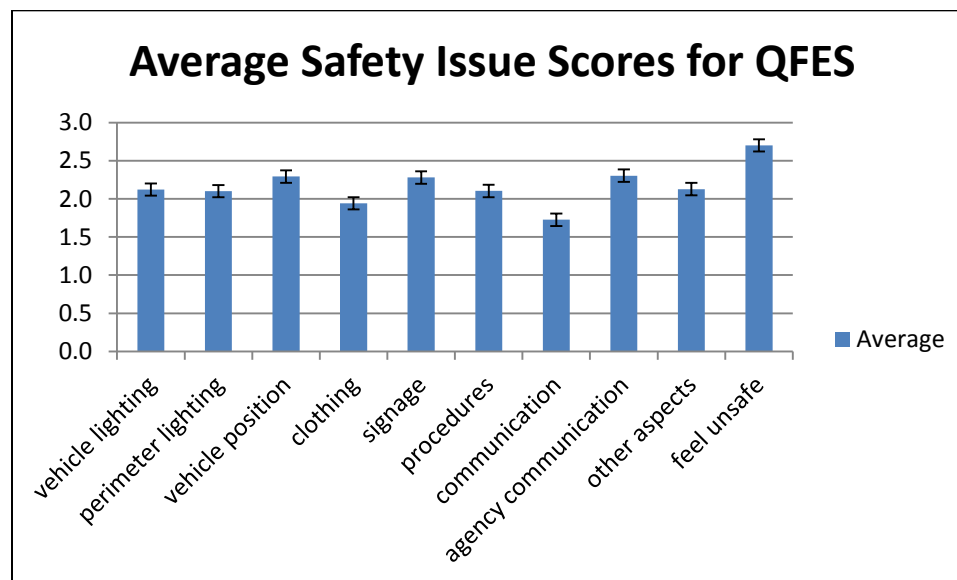
An inspection of the means across organisations identifies RACQ as having the most concerns of responder organisation regarding safety, especially around issues with vehicle lighting (Mean = 3.3), vehicle positioning (Mean = 3.0) and procedures and protocols (Mean = 3.1).

**Figure 2: Average Scores for Safety Issues for the Traffic Response Unit**

The Queensland Police Service respondents represented the largest group in the survey and therefore the highest safety issues for QPS are the same as the overall issues. Their greatest concerns were perimeter lighting (Mean = 2.4), signage (Mean = 2.4) and feeling unsafe (Mean = 2.5).



*Figure 3: Mean scores for QPS participants*



*Figure 4: Mean scores for QFRS participants*

QFES overall scores were the lowest of any organisation, but the highest for feeling unsafe at traffic incidents. Their main concerns were feeling unsafe at traffic incidents (2.7), vehicle position (2.3), signage (2.3), and interagency communication (2.3).

## Qualitative Results

Given the significant differences between organisations regarding their perspectives of safety issues at traffic incidents, further investigation of the compatibility of the experiences of responders from the different organisations was undertaken. Analysis of written responses using the Leximancer tool aimed to

establish if the experiences were similar but attitudes differed due to the differing roles of each responder group or organisational cultural factors, or if their experiences were not compatible leading to differences of perspective due to different mental models of what was occurring at the incident scenes.

Leximancer determined major themes of discussion (from highest to lowest incidence) and also related concepts (also from highest to lowest incidence). In the concept maps for each organisation (below), the themes are represented by circles and the related concepts are the words within each theme. Therefore it is possible to reflect on the main themes of conversations and the types of words they were using when discussing these themes.

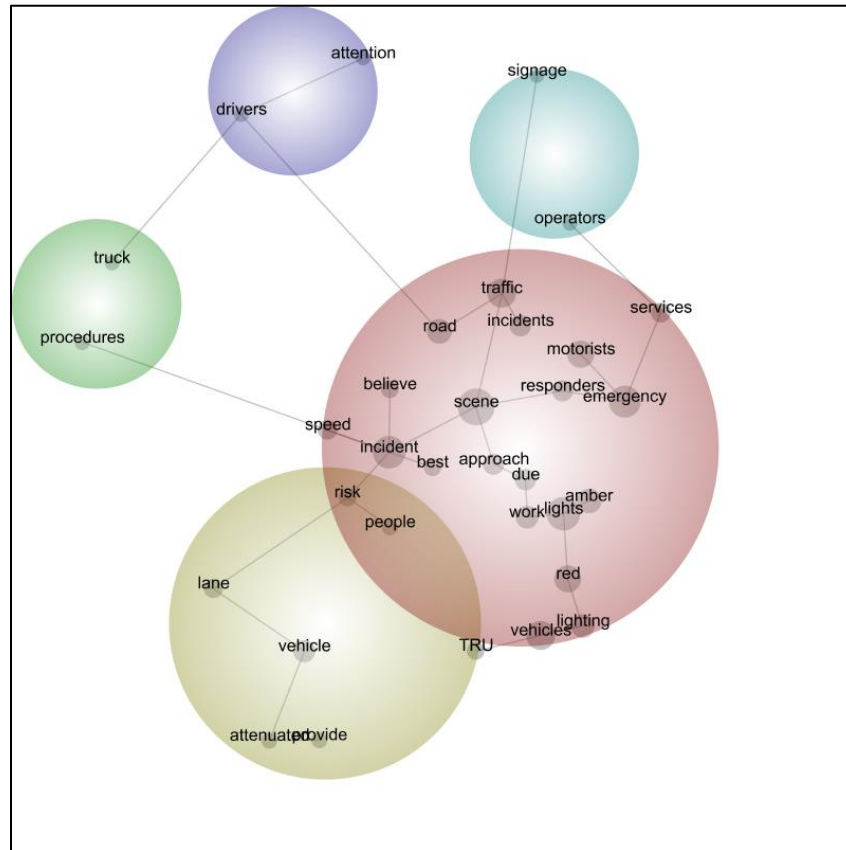
RACQ's TRU officers discussed five main themes. Of these 'scene' and 'vehicle' were the main themes and 'procedures', 'operators' and 'drivers' were outlier themes. By far the largest theme was scene indicating a TRU focus on issues with scene safety.

**Table 2: TRU Themes**

Theme	Associated Words	Example Comments
Safety	lights, incident, emergency, vehicles, traffic, motorists, red, road, amber, lighting, work, responders, speed	<p><i>"The more agencies on site the greater the problem. Especially when setting up an incident <b>scene</b> - it'd be good to have procedures about <b>scene</b> setup if you can't communicate at <b>scene</b>."</i></p> <p><i>"If no red and blue <b>emergency lights</b> are present at the <b>scene</b> then driver behaviour is not normally changed to a sufficient safe level until <b>emergency vehicles</b> arrive."</i></p> <p><i>"Smash Tow operators regularly pull up on <b>scene</b> behind the <b>vehicle</b> with arrow board and <b>traffic</b> cones, blocking the vision of approaching <b>motorists</b>. Also they regularly pull into the inner cordon that has been set up in anticipation of <b>emergency</b> services arriving."</i></p>
Vehicle	lane, risk, TRU, people, attenuated, provide	<p><i>"Approval is required to park our <b>vehicle</b> in a <b>lane</b> if a <b>risk</b> assessment requires it to be there. My <b>vehicle</b> was my protection, now I feel very unsafe."</i></p> <p><i>"The current rule forcing a 150m gap between the <b>attenuated vehicle</b> and the incident is dangerous as people have not perceived enough of a <b>risk</b> to assess the scene and <b>REGULARLY</b> cut back into the closed <b>lane</b> <b>BEFORE</b> the obstruction."</i></p>
Procedures		<i>"Our <b>procedures</b> from the TRUMM don't often provide the appropriate solution as there should be more flexibility around allowing the responding TRO to identify best course of action."</i>
Operators		<i>"Emergency services sometimes have difficulty differentiating between TRU's and smash tow <b>operators</b>."</i>
Drivers		<i>"The general public and even emergency services think that we are often road workers or tow truck <b>drivers</b>."</i>



The TRU themes and related concepts are detailed in the figure below.



**Figure 5: Traffic Response Unit Concept Map**

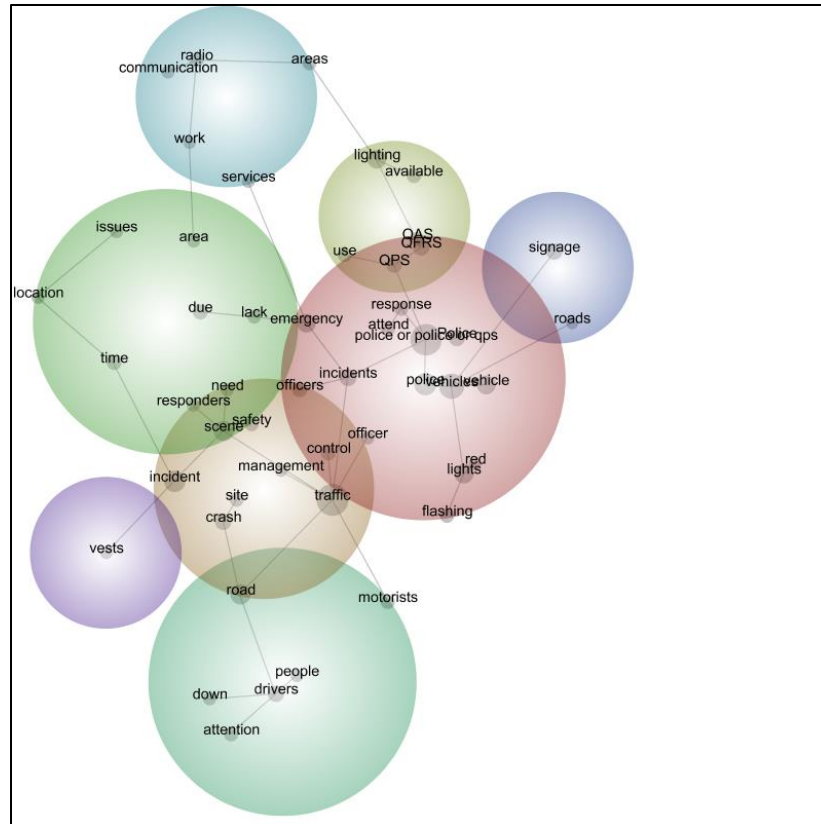
The responses from QPS contained seven themes. Of these, ‘traffic’, ‘vehicle’ and ‘lighting’ were the main themes and ‘drivers’, ‘radio’, ‘location’ and ‘vests’ were outlier themes. Their major concerns centred around driver behaviours, inadequate lighting/signage/resources as well as some procedural issues.

**Table 3: QPS Themes**

Theme	Associated Words	Example Comments
Traffic	incident, road, scene, control, officers, time, site, safety, lack, responders and management	<p><i>“We need to have light bars that display text to motorists, they attempt to stop and ask/see what’s going on. A simple <b>“Traffic Accident”</b> digital display would be very effective for all general duties police vehicles.”</i></p> <p><i>“Firefighters tend to pull up everywhere and anywhere without thought for <b>traffic</b> direction or diversions by police around the <b>incident</b>.”</i></p> <p><i>“Back to inefficient <b>traffic</b> control measures, and <b>lack</b> of communication. I have stepped into the path of oncoming <b>traffic</b> because someone decided that that lane was fine to be open and</i></p>

		<p><i>hadn't communicated that."</i></p> <p><i>"Traffic Response Unit vehicles need to be fitted with red/blue lights. TRU need to access the <b>scene</b> quicker and be able to move <b>traffic</b> to access the accident <b>scene</b> in a timely manner."</i></p> <p><i>"Walkie talkies would be useful for <b>officers</b> on foot to communicate with others when conducting <b>traffic management</b> and separated from others."</i></p>
Vehicle	police, lights, emergency, incidents, police and flashing.	<p><i>"Police Van (iLoad) <b>emergency lights</b> are not clearly visible from rear due to height of the pod."</i></p> <p><i>"Often <b>emergency lights</b> are <b>flashing</b> at minor <b>incidents</b> where all <b>vehicles</b> are off the road and this causes a distraction to passing motorists."</i></p> <p><i>"QPS <b>vehicles</b> should be dispatched the same as other <b>emergency</b> services. I have attended two crashes now where QAS, QFRS and all involved persons had left prior to <b>Police</b> arrival."</i></p> <p><i>"It would be useful to have some <b>flashing lights</b> that can be removed from the <b>vehicles</b> and placed in the road in addition to those mounted on <b>vehicle</b>. Not all <b>police vehicles</b> carry witches hats and this can have an added impact on officer safety."</i></p>
Lighting	Signage, QFRS, QPS and QAS	<i>"Perimeter <b>lighting</b> is mostly poor or non-existent."</i>
Drivers		<p><i>"Tow truck <b>drivers</b> can be a little frustrating to communicate with."</i></p> <p><i>"Just need the respect of the <b>drivers</b> to be effective."</i></p>
Radio	Services, area, communication, work	<i>"We have poor <b>radio communications</b> with our Comms (little radio space at busy times so important information therefore does not get relayed. Depending where incident is may mean we need to use our personal phones to communicate to Comms."</i>
Location	Issues, times	<i>"Depending on <b>location</b> it [signage] can create <b>issues</b> when resources are not readily available. Little temporary signage available for use especially at major incidents."</i>
Vests		<p><i>"I believe a review is required into the colour of our current <b>vests</b>. This green/yellow blends with background."</i></p> <p><i>"The current reflective <b>vests</b> and raincoats restrict access to equipment housed on the belt. The shirts should have built in reflective strips."</i></p>

The figure below details the concept map for QPS written responses to the survey.



**Figure 6: QPS Concept Map**

Eight themes emerged from the QFES written responses. Of these, ‘traffic’, ‘lights’ and ‘lighting’ were main themes with ‘drivers’, ‘QFES’, ‘police’, ‘signage’, and ‘people’ as outlier themes. QFES responses were centred around issues with other drivers, managing traffic without training and issues with other organisations.

**Table 4: QFES Themes**

Themes	Associated Words	Example Comments
Traffic	incident, vehicles, QPS, road, scene, position, safety, time.	<p><i>“We are not to direct <b>traffic</b> but we do.”</i></p> <p><i>“... I am aware that the SES has issues with stopping <b>traffic</b>. People don't slow down enough and the reason I and the representatives believe is the <b>traffic</b> doesn't take any notice of amber flashing light at an <b>incident</b>.”</i></p> <p><i>“The headlights of the emergency <b>vehicles</b> parked at the incident can sometimes blind the <b>traffic</b>.”</i></p> <p><i>“The general requirement for <b>QPS</b> approval to move <b>vehicles</b> is counterproductive. <b>QFES</b> officers can authorise the removal of</i></p>

		<p><i>vehicles if it is a <b>safety</b> issue however this should be expanded to include the need to maintain <b>traffic</b> flow and help prevent secondary <b>incidents</b> in banked up <b>traffic</b>.</i></p> <p><i>“QFES, QPS, QAS do not have common channels for radios and different priorities for <b>traffic incident</b> management.”</i></p>
Lights	Vehicle, emergency, tow, warning	<p><i>“Problems were more prevalent prior to the inclusion of Blue lights on vehicles.”</i></p> <p><i>“The quality of equipment is poor and usually at least some of the warning lights on the vehicle are not operational or not operating correctly”</i></p>
Lighting	Appliances, fire	<i>“Unable to turn off some strobe <b>lights</b> when dazzling road users. All warning <b>lights</b> on fire appliances are currently controlled through two switches leaving little operator choice.”</i>
Drivers	Speed, accident	<p><i>“As firefighters we regularly show up and the vehicles are gone. Police often never show up so drunk <b>drivers</b> walk away.”</i></p> <p><i>“I would like to see more Council response vehicles situated around Brisbane as they can erect signage and alert <b>drivers</b> before they reach the <b>accident</b> scene.”</i></p>
QFES	QAS	<p><i>“QAS and QFES can give two separate pieces of information, to the same job.”</i></p> <p><i>“QFES are often called on to assist QAS in the handling of casualties. Extra training in the use of QAS stretchers would be useful.”</i></p>
Police	times	<i>“Mainly delays removing cars whilst waiting for <b>police</b> to attend. It can take over an hour at <b>times</b> for them to arrive.”</i>
Signage		<i>“Are we as QFES covered if we are directing traffic without any training, approved <b>signage</b> etc?”</i>
People	attention	<i>“<b>People</b> that are driving past rubber necking and not paying <b>attention</b> to their surrounds.”</i>

The concept map for QFES responses is depicted in the figure below.



## Discussion and Conclusions

Emergency responders at roadside crashes are working in a dangerous environment and the complexity of issues and their interaction is evident in the survey responses received in this study. Overall the study identified that the major concerns of responders were perimeter and vehicle lighting, signage, interagency communication, procedures and protocols and the overall feeling of being unsafe.

The themes raised by the different responder organisations varied according to agency perspectives and foci and the lack of congruence suggests that the mental models of incidents scenes from responders of different agencies may be different and perhaps cognitively incompatible. This is an important step moving forward as it suggests that safety solutions for TIM will need to be agency focused rather than holistic. The study also gives direction regarding the focus for safety gaps in current TIM practices. First and foremost, it is important that responders feel safe in their work environment. Other issues include inter-agency communication, the coordination for timing agency responses to incidents, vehicle and perimeter lighting, and some procedures and protocols.

There was evidence of a breakdown in inter-agency respect and understanding especially around QFES parking in the 'fend off' position, QAS focus on motor accident victims to the exclusion of other agency requirements, the timeliness of the QPS response, and lack of understanding of other emergency responders regarding the TRU role.

However there was also evidence of inter-agency empathy over concerns. Several responses from QPS and QFES relayed their frustration over TRU amber light restrictions and QPS responses reflected QFES concerns over delays in the QPS response.

The current study identified safety issues at incidents from the perspective of emergency responders working at traffic incidents. The responders from different agencies differed in their beliefs around safety issues suggesting cognitive incompatibility.

This study is part of an ongoing body of research. In the next stage of the study Critical Decision Method interviews will be conducted to establish certainty around the question of cognitive compatibility and also to better identify safety gaps in current TIM practices. Potential options to improve safety at traffic incidents will be tested using driver simulation studies.

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