

From on High? A Systems Analysis of the Contributory Factors that Lead to the Fatal Five Behaviours

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Abstract

Although much is known regarding driver-related crash contributory factors, less is known regarding the crash contributory factors that reside outside of the driver, vehicle and road infrastructure. This article presents the findings from a study in which a systems thinking framework was used to collect and analyse data on the system-wide contributory factors underpinning the so called “fatal five” crash-related driver behaviours: drug and drink driving, distraction and inattention, failure to wear a seat belt, speeding, and fatigue. The study included a survey on drivers’ perceptions of causes of the each behaviour and a workshop with road safety experts. The data was analysed and mapped onto a systems model of the Queensland road transport system. In addition to well-known driver-centric contributory factors, factors related to road safety strategy and policy, design standards, road rules and regulations, and societal issues generally were identified.

Background

In the last decade, the potential utility of applying systems theory and methods in transportation safety research and practice has been recognised (Larsson et al., 2010; Salmon & Lenné, 2015; Salmon et al., 2012). This approach involves the use of systems analysis methods to describe overall road transport systems and identify the system-wide factors that influence road user behaviour and safety. In response, researchers have undertaken various applications of systems analysis methods to investigate the causes of road trauma. Whilst these initial applications have shed new light on the system-wide causes of road trauma, a significant limitation is the fact that most systems-based studies have focused only on a single catastrophic event and/or analysis of existing crash data only (e.g. Newnam & Goode, 2015; Newnam et al., 2017; Salmon et al., 2013). This has impacted the generalisability of findings and has raised the requirement for further research utilising other data sources.

In response, this article describes a study that aimed to go beyond accident data and case studies to investigate the system-wide factors underpinning drivers’ engagement in the so-called fatal five behaviours known to contribute to road crashes:

1. Drug and drink driving;
2. Distraction and inattention;
3. Failure to wear a seat belt;
4. Speeding; and
5. Fatigue.

The study involved building on a recently developed systems model of the Queensland (Qld) road transport system (Salmon et al., 2016; see Figure 1) by combining a driver survey and an expert workshop to identify fatal five contributory factors across the Qld road transport system. The aim

was to identify: (a) what factors lead to drivers engaging in each of the fatal five behaviours; and (b) where these factors reside in the Qld road transport system.

The Qld road transport system

Salmon et al. (2016) presented a control structure model of the Qld road transport system showing the actors and organisations that operate within the road transport system, along with the control and feedback relationships that exist between them (see Figure 1). Within Figure 1, the downward flowing arrows and text linking the higher levels to the lower levels represent control mechanisms imposed by actors and/or organisations at the level above on actors and/or organisations at the level below. For example, Police officers at Level 4 of the model impose control on the road users at Level 5 via monitoring, enforcement and penalties. Likewise, at Level 1 national and federal parliaments impose control on the level below (government agencies, industry associations, user groups and the courts) through national policy. Control relationships also exist between non-adjacent levels (as represented by curved arrows). For example, at Level 3 the Department of Transport and Main Roads imposes licensing and registration controls on road users at Level 5.

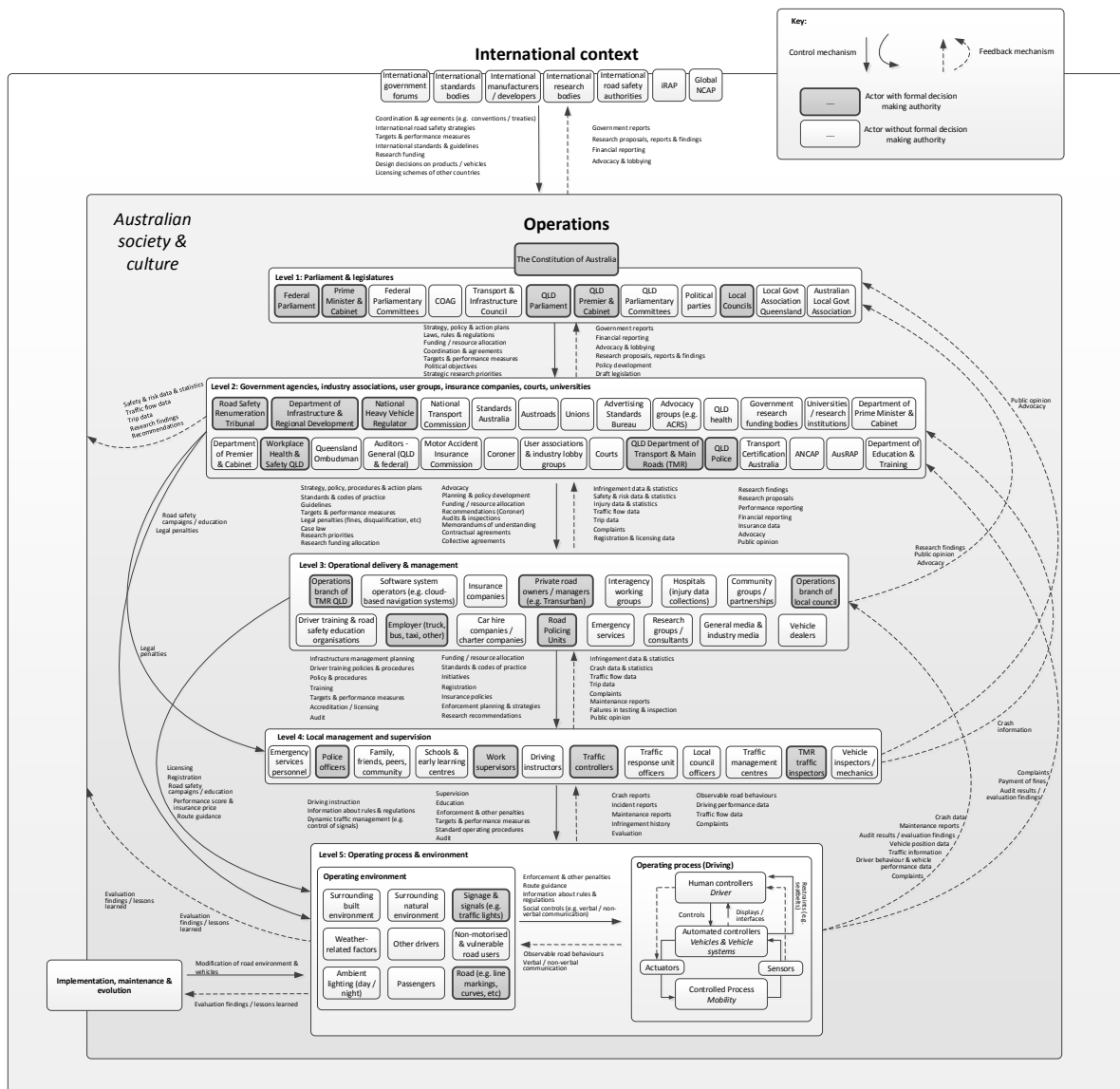


Figure 1. Qld road transport system operations control structure

The dashed arrows flowing upward represent feedback mechanisms whereby actors and /or organisations provide information regarding the status of the system to those higher up. For

example, 'Government reports' are a feedback mechanism provided by Level 2 (government agencies, industry associations, user groups and the courts) to Level 1 (parliament and legislatures). At the lower levels of the system, crash reports are provided to Police officers (Level 4) by road users (Level 5) who were either involved in the crash or witnessed the crash. Feedback relationships exist between adjacent levels of the control structure (shown by straight dashed arrows) and also between non-adjacent levels (shown by curved dashed arrows).

A key implication of the control structure model is that road crashes within this system have contributory factors across the control and feedback loops described. In turn, this suggests that the factors that lead to drivers engaging in the fatal five behaviours will span all five levels of the system. The present study aimed to identify what the contributory factors are and where they reside within the Qld road transport system.

The aims were achieved through the conduct of two studies:

1. *Surveys of road user perceptions on the causes of each fatal five behaviour.* Participants completed surveys designed to elicit their perceptions on why drivers engage in each fatal five behaviour; and
2. *A road safety subject matter expert workshop.* Six road safety experts took part in a workshop designed to elicit their perceptions on the causes of each fatal five behaviour.

Method

Driver survey

A survey instrument was developed to gather data on drivers' perceptions of the factors that influence engagement in each of the fatal five behaviours. For the purposes of this study, drink and drug driving was subdivided into 'drink driving', 'drug driving (illicit drugs)' and 'drug driving (prescription drugs)'. Driving without a seatbelt was subdivided into 'driving without a seatbelt' and 'driving without using child restraints'. This yielded a total of eight 'fatal five' behaviours that were examined in the survey. Formal approval for the study was granted by the University of the Sunshine Coast's research ethics committee.

The survey initially asked a series of questions designed to gather demographic data. Following the demographic questions participants were asked the following questions in regard to each of the eight behaviours (note the example below relates to fatigue only):

1. Have you ever driven while you were (or suspected you were) fatigued?
2. Thinking about a time that you, or someone you know, drove when they were fatigued, please briefly describe the reason/s for engaging in fatigued driving.
3. In general, what do you think are the reasons why people drive while they are fatigued?
4. What do you think could be done to prevent people driving while they are fatigued?

The study was advertised via a Centre for Human Factors and Sociotechnical Systems mailing list containing the details of previous road safety study participants and on social media (Facebook and Twitter). Participants were directed to the on-line survey via a web link which was open between the period April 2016 – June 2016. Upon completing the survey participants were provided with a link to enter into a prize draw to win an iPad.

Data analysis

Participant responses related to each of the eight behaviours were subject to content analysis using NVivo 10. Inter-rater reliability checks were conducted on 20% of the data relating to each behaviour. Percentage agreement ranged from 75.2% (drink driving) to 91.7% (driving without using child restraints).

Expert workshop

Six systems thinking in road safety experts took part in an expert workshop designed to identify factors across the road transport system that influence drivers' engagement in the fatal five behaviours. The participants were selected based on their previous involvement in road safety research studies underpinned by a systems thinking approach or involving systems analysis and design methodologies. This was criteria included a requirement to have authored peer reviewed journal articles involving the application of systems thinking theory, principles, and/or methods to road safety issues.

The workshop involved reviewing the survey data for each of the eight behaviours, mapped onto Salmon et al.'s (2016) control structure model, and then discussing additional contributory factors that the experts believed were relevant. When the experts agreed that a factor was relevant, a discussion was held regarding where on the control structure model the contributory factors resided. Once placement was agreed upon sticky notes were used to place the contributory factor on an A1 printout of the model.

Results

Survey

316 participants completed the survey. Most participants were aged between 41 and 70, had over 20 years driving experience, and had resided in Qld for over 20 years. A summary of participants' gender, age, time spent living in Qld, and driving experience is presented in Table 1.

Table 1. Survey participant demographics

Gender	Age	Years lived in Qld	Years driving experience
Male 53% Female 47%	18-25 16.0% 26-49 18.4% 41-55 31.3% 56-70 38.2%	<1 year 2.4% 1-5 years 6.0% 6-10 years 7.9% 10-15 years 9.8% 16-20 years 6.0% 20-25 years 11.7% 26+ years 53.8%	<1 year 3.5% 1-5 years 10.4% 6-10 years 8.2% 10-15 years 13.3% 16-20 years 7.3% 20-25 years 11.1% 26+ years 45.2%

Engagement in fatal five behaviours

Participants' responses to the question of whether they had previously engaged in the fatal five behaviours whilst driving are presented in Table 2.

Table 2. Participants' previous engagement in fatal five behaviours

	Driving while fatigued	Driving with a blood alcohol level above 0.05	Driving while under the influence of illicit drugs	Driving while under the influence of prescription drugs	Driving while distracted (e.g. by mobile phone use)	Speeding	Driving without a seatbelt	Driving without child restraints
Yes	66.5%	32.3%	10.1%	12.3%	66.1%	76.9%	23.4%	9.5%
No	19.9%	52.9%	76.9%	71.2%	19.3%	9.5%	53.2%	67.4%
Prefer not to say / no response	13.6%	14.9%	13.0%	16.5%	14.6	13.6%	23.4%	23.1%

Three-quarters of participants reported having previously driven above the speed limit. Two-thirds of participants reported having previously driven either while fatigued and/or distracted. Around a

third of participants reported having previously driven with a blood alcohol level above 0.05. Almost a quarter of participants reported having previously driven without wearing a seatbelt and almost a tenth also reported driving with children who were not appropriately restrained (9.5%). Around one in ten of participants reported that they had previously driven whilst under the influence of illicit (10%) or prescription (12%) drugs.

Fatal five contributory factors

For the present article only those contributory factors reported by over 10% of the participant sample are presented. The factors that 10% or more participants reported to contribute to drivers' engagement in each of fatal five behaviours are presented in Table 3.

It is notable that most factors reported by survey participants were personal factors relating specifically to drivers themselves. For example, factors such as stupidity/ignorance, emotions and stress, lack of understanding of the risks, impairment, complacency/optimism bias, perception of not being caught, and laziness are all driver-centric factors. Participants did, however, report a selection of factors concerned with the wider road transport system and even society generally. These included mobile phones (distraction), social and cultural issues (drink driving), a lack of alternative transport options (drink and drug driving), work requirements and shift work (fatigue), unreasonable speed limits (speeding), and the cost of fitting restraints (failing to use child restraints).

Expert workshop

Fatal five contributory factors

A selection of the factors identified in the expert workshop as contributing to drivers' engagement in each of the eight behaviours are presented in Table 4 (it is beyond the scope of this paper to include them all). The factors presented were chosen in order to give examples of factors across all levels of the road transport system as per Salmon et al's (2016) model.

A number of the factors identified were deemed to be relevant across all of the eight behaviours, such as crash data limitations, a lack of alternative or affordable transport options, and inadequate enforcement and financial constraints on enforcement.

An interesting feature of the expert workshop findings was the identification of societal issues that were deemed to reside outside of the road transport system but still play a contributory role in road crashes. Examples included an increased societal pressure to remain connected through modern technology (distraction), social problems such as drinking and illicit and prescription drug use, a culture of high productivity (fatigue) and society's acceptance of speeding and driving while fatigued.

A final notable aspect of the expert workshop was that various factors identified were deemed to reside at the higher levels of the road transport system. Examples included limitations in vehicle design standards (distraction), the lack of an independent road safety regulator (distraction, fatigue), financial constraints around enforcement activities, a disconnect between road safety regulation and occupational health and safety, and employers not taking responsibility for employee safety outside of work (fatigue).

Table 3. Fatal five contributory factors from survey

Distraction & Inattention	Drink Driving	Drug Driving (illicit)	Drug Driving (prescription)	Fatigue	Speeding	Seatbelts	Child restraints
<ul style="list-style-type: none"> • Mobile phones 47.8% • Interactions with children in vehicle 26.9% • Passenger interactions generally 22.5% • Radio/stereo 15.2% • Lack of attention generally 15.5% • Emotions/Stress 13.6% • Complacency/Optimism bias 10.8% • Impairment 10.8% 	<ul style="list-style-type: none"> • Lack of understanding of risks 31.0% • Complacency/Optimism bias 29.7% • Lack of alternative transport options 22.5% • Impaired judgement 17.1% • Perception that they won't get caught 16.8% • Unaware that they are over limit 16.8% • Social and cultural influences 16.5% • Stupidity/Ignorance 14.9% • Necessity of driving 10.8% • Short distance/close to home 10.8% 	<ul style="list-style-type: none"> • Irresponsible 21.5% • Impaired judgement 16.8% • Unlikely to be caught 15.8% • Do not recognise impaired 15.2% • Stupidity/Ignorance 15.1% • Addiction 10.4% 	<ul style="list-style-type: none"> • Necessity of driving 15.5% • Lack of alternative transport options 13.0% • Do not recognise impaired 11.4% • Complacency/Optimism bias 11.1% 	<ul style="list-style-type: none"> • Time pressure 26.9% • Work requirements 18.4% • Necessity of driving 15.8% • Do not recognise impaired 17.7% • Shift work 14.2% • Long trips 13.3% • Family & social expectations 10.1% 	<ul style="list-style-type: none"> •Lack of awareness regarding speed 28.8% •In a hurry 20.3% •Late 19.0% •Unreasonable speed limits 16.8% •Considered non-compliance 14.6% •Overtaking 13.3% •Impatience 13.0% 	<ul style="list-style-type: none"> • Laziness 19.9% • Stupidity/Ignorance 15.5% • Short trip 14.2% • Forgetfulness 12.7% • Discomfort 10.8% 	<ul style="list-style-type: none"> • Cost of fitting restraints 22.5% • Laziness 14.9% • Stupidity/Ignorance 11.4%

Table 4. Fatal five contributory factors identified during expert workshop

Control structure level (refer Fig. 1)	Distraction and inattention	Drink driving	Drug driving (illicit)	Drug driving (prescription)	Fatigue	Speeding	Failing to wear a seatbelt/use child restraints
Overall system	Silos (e.g. between transport planners, urban planners, road safety practitioners, health system and the Police) Lack of feedback between coroners, police and the design of road systems Crash data limitations (reporting, analysis, dissemination, role in policy and interventions)						
Societal issues	Societal desire/pressure to remain connected Saturation of mobile phones	Societal drink problem/levels of consumption	Societal drug problem/levels of consumption	Societal drug problem/levels of consumption Difficult for authorities to keep up with new drugs coming into market Society's failure to acknowledge the problem	Culture of high productivity Social acceptance of fatigued driving	Whole social environment encourages speeding "We haven't won the hearts and minds on speed"	Social norms of not wearing seatbelts in other forms of transport e.g. buses/taxis
1. Parliament and Legislatures	Lack of clarity around responsibility for distraction	Financial constraints around enforcement	Drug driving less of a govt priority compared to other behaviours	Drug driving less of a govt priority compared to other behaviours	Fatigued less of a govt priority compared to other behaviours	Financial constraints around enforcement	
	Lack of an independent road safety regulator		Financial constraints around enforcement	Financial constraints around enforcement	Financial constraints around enforcement		
2. Government agencies, industry associations, user groups, insurance companies, universities, courts etc	Limitations in vehicle design standards	Poor urban planning (e.g. urban sprawl)	Failure to gain support from Unions for testing	Failure to gain support from Unions for testing	Rules and regulation around work-related driving	Flawed speed limit setting process	Vague/unclear rules
	Absence of human factors training and education for road system designers	Lack of facilities for leaving vehicles	Disconnect between OHS regulation and work driving incidents	Lack of knowledge on impacts	Financial constraints around enforcement	Social media	
	Vehicle design (e.g. lack of human factors integration)	Rules and regulation around controls e.g. interlocks	Lack of research on safe limits	Financial constraints around enforcement	Employers not taking responsibility for employee safety	Financial constraints around enforcement	
	Media and social media encouragement to engage in distracting behaviours	Financial constraints around enforcement	Financial constraints around enforcement	Inadequate standards for warning labels/patient information	Lack of knowledge on issue		
3. Operational delivery and management	Rapid technological advancement (integration is lagging behind)	Financial constraints around enforcement	Absence of testing by employers	Absence of testing by employers	Job design	Financial constraints around enforcement	Lack of fitting/technical advisory service
	Focus of vehicle design on integrated media experience		Financial constraints around enforcement	Financial constraints around enforcement	Lack of education on risks		Lack of a checking mechanism
	Lack of communication and interaction between organisations/institutions			Medical professional reluctant to take away drivers' licences e.g. elderly	Financial constraints around enforcement		
4. Local management and supervision	Inadequate enforcement	Inadequate enforcement	Inadequate enforcement	Absence of prescription drug testing	Lack of a fatigue test	Inadequate enforcement	
	Lack of school education around safe use of mobile phones			Inadequate enforcement	Inadequate enforcement		
5. Operating process and driving environment	Lack of rest stops	Number of people with a medical issue around alcohol	Lack/affordability of public transport options	Economic pressures (e.g. people have to drive to get to work)	Absence of feedback mechanism	Vehicle design	Vehicle design (comfort, lack of seatbelt detection systems)
		Lack/affordability of public transport options			Perception that it isn't a problem	Lack of speed cameras	Lack/affordability of public transport options

Discussion

This study aimed to go beyond limited accident data to investigate the system-wide factors potentially underpinning drivers' engagement in the so-called fatal five behaviours known to lead to road crashes (drug and drink driving, distraction, failure to wear a seatbelt, speeding, and fatigue). Based on a survey of driver behaviour and an expert workshop, contributory factors were identified and mapped onto Salmon et al.'s (2016) Qld road transport system control structure.

An interesting finding from the survey data was the level of acceptance that there appears to be around each of the behaviours examined. For example, speeding and driving while distracted and while fatigued were all reported as having been engaged in by over two-thirds of the survey sample. This is in comparison with other more ostensibly unacceptable behaviours such as drink and drug driving and not wearing a seatbelt, which were reported as being engaged in by far less of the sample. These findings may suggest that increased attention should now be placed on the more overtly acceptable fatal five behaviours such as speeding and driver distraction. This is emphasised by one workshop participant who expressed "we have not won the hearts and minds on speeding".

With regard to specific contributory factors, the findings from the survey indicate that drivers perceive the causes of the fatal five are driver-centric and relate specifically to the drivers themselves. This is evidenced by the fact that, across the behaviours examined the majority of contributory factors reported centred around the driver and aspects of their personality, knowledge or psychological state. For example, factors identified include stupidity/ignorance, emotions and stress, lack of understanding of the risks, impairment, complacency or optimism bias, perception of not being caught, and laziness. Although survey participants did report a selection of factors concerned with the wider road transport system and even society generally, the findings suggest that Qld drivers believe the fatal five to be predominantly a driver-centric problem.

The survey findings were in contrast to the expert workshop findings which had a much broader road transport system focus. Important findings from the expert workshop were the key role that wider societal problems appear to play in the fatal five behaviours and road trauma. That is, while the direct instigator of the behaviour is the individual, some of the reasons for the individual engaging in that behaviour stem from broader societal issues largely beyond the individual's control. Examples of such issues identified included increasing societal pressure to remain connected (distraction), drinking and illicit and prescription drug use, a culture of high productivity (fatigue) and society's acceptance of speeding and driving while fatigued. An important question to emerge from these findings is whether it is appropriate for road safety stakeholders to attempt to deal with large-scale societal problems in isolation from other groups and organisations, or whether a more integrated public health approach may prove more successful. Indeed, recent investigations have suggested that an integrated approach to public health, urban planning and transport safety is likely to achieve greater public health and road safety gains than a 'siloed' approach (McClure et al., 2015). The findings of the present study suggest that a similar integrated approach to public health, urban planning and road safety may alleviate some of the contributory factors identified by providing more accessible and safer alternative transport options to driving.

Taken together the findings from this study have important implications for preventing the fatal five behaviours and road trauma. Whilst many of the driver-centric contributory factors identified continue to be tackled by road safety practitioners through avenues such as driver education and awareness campaigns, enforcement activities, and driver training, the findings suggest that interventions aimed at the higher levels of road transport systems may prove beneficial. For example, some of the factors relating to driving while distracted suggest that improvements to design standards for both mobile phones and in-vehicle devices are required. Likewise, the initiation of activities to increase the knowledge base around driving under the influence of prescription drugs and driving while fatigued will enable both to be better prioritised in road safety

policy and strategy. Finally, the findings suggest that enhancing the system around road safety enforcement could prove beneficial in preventing all of the fatal five behaviours. Whilst increasing the budget available to support effective enforcement activities is important, the development of valid and reliable tests for prescription drugs and fatigue should continue to be investigated.

One consideration identified in the workshop is whether a strict enforcement mindset hinders our ability to learn about the true motivations for behaviour. Exploring the potential to introduce a just culture approach to road safety enforcement is an interesting area for future research. Just culture approaches aim to balance the need for accountability with the need to learn from accidents. They acknowledge that system change, rather than punishment, is a more appropriate response to behaviours such as genuine errors, while wilful or reckless actions are not tolerated (Dekker & Breakey, 2016; Reason, 1997). Such approaches, along with well-designed reporting systems, encourage people to report events such as near misses and non-compliances without fear of unjust punishment. In addition, they can encourage honesty during incident investigations, enabling the collection of richer data about the causes and contributing factors of accidents. Further research into the practicality of implementing just culture approaches in road safety is recommended.

A final important implication relates to the crash data systems that are currently used in road transport systems. In combination with other studies (e.g. Newnam & Goode, 2015) the findings suggest that there are important crash contributory factors that reside at the higher levels of road transport systems. In turn, this raises the question of whether current road crash data collection and analysis systems are identifying the full network of contributory factors involved in road crashes. Most crash data systems typically only identify contributory factors related to drivers, their vehicles, and the road environment, with little information available regarding less direct contributory factors residing at the higher levels of the system (Salmon et al., 2016). Whilst the present study suggests that there are important factors outside of the driver, vehicle and road environment that play a role in crashes, there appears to be no data available to investigate specifically their role in crashes. The development of systems thinking-based crash data collection and analysis systems is a key future research requirement that has previously been articulated (e.g. Salmon et al., 2016) and is one that is further emphasised through this study. Notably, similar systems have been developed in other domains and have resulted in advances in the knowledge base around the contributory factors involved in accidents (see Salmon et al., 2017). It is important to note, however, that this is not a straightforward endeavour. Indeed initial investigation is required on the practicalities associated with implementing more comprehensive crash data collection and analysis systems. In particular, the extent to which already time poor Police officers are able to identify and record wider system contributory factors is of interest.

An important limitation to acknowledge was the small number of experts used in the workshop. Whilst the authors are confident that the group were comprehensive when identifying contributory factors, potentially a larger expert group would have identified additional factors. Further workshops involving a larger group of experts would remove this limitation. Indeed, a useful future study would be to repeat the current study in all Australian states with a larger survey sample and set of experts.

In closing, this study has added to the growing consensus that road trauma is created by a network of interacting factors that span all levels of road transport systems. It is hoped that the systems thinking approach continues to gain traction in road safety circles and that further studies will contribute to this important knowledge base. Further applications in the road safety context are encouraged, particularly around crash causation, the composition of road systems, and the influence of higher level actors and organisations on the behaviour of others such as road users and road designers. It is these authors opinion that the rich outputs from such applications will support the optimisation of road transport systems and attainment of further road safety gains.

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