

## Work-Related Road Safety Risk Assessment: Utilisation of Self-Report Surveys to Predict Organisational Risk

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### Abstract

Work-related driving safety is an emerging concern for Australian and overseas organisations. Research has shown that road crashes are the most common cause of work-related fatalities, injuries and absences from work. This study's objectives were to identify driver characteristics which pose potential risks to work-related driving safety within the organisation, as well as determining the value of such self-reported data to predict crash involvement and general aberrant driving behaviours. This paper reports on a study examining the predictive utility of predominant self-report questionnaires to identify individuals involved in work-related crashes within an Australian organisational fleet setting ( $N = 4195$ ). Survey questionnaires included the Manchester Driver Behaviour Questionnaire (DBQ), Driver Attitude Questionnaire (DAQ), Safety Climate Questionnaire – Modified for Drivers (SCQ-MD) and Risk Taking. The tools were distributed through the company's internal mail system to employees who volunteered to participate in the study. An important finding to emerge was that a potential fleet "speeding culture" was identified from univariate analyses. For example, drivers were most likely to report engaging in speeding behaviours and also believed that speeding was more acceptable compared to drink driving, following too closely or engaging in risky overtaking manoeuvres. However, multivariate analysis determining factors associated with self-reported crash involvement revealed that increased work pressure and driving errors were predictive of crash risk, even after controlling for exposure on the road. This paper highlights the major findings of the study and discusses the implications and difficulties associated with utilising driver behaviour measurement tools within contemporary organisational fleet settings.

### Keywords

Work-Related Road Safety; Driver Behaviour; Speeding Culture; Risk

### Introduction

#### *Work-Related Road Safety Environment*

Work-related crashes are currently the leading cause of workplace death and injury in many major developed countries around the world. In the United States, various studies have reported that between 25% [1] and 33% [2] of all workplace deaths are attributable to road crashes. In other parts of the world, work-related crash fatality figures are similarly concerning. For example, in Finland estimates have ranged between 38% and 63% [3]. Similarly, work-related crashes reportedly account for around 40% of all road crash fatalities in France [4] (more if commuting cases are included), 30% in Canada [5], and around 25% in the United Kingdom [6], Denmark and Sweden [7].

In Australia, it is estimated that approximately a third of all travel is work related and if work-related commuting is included in calculations, this estimation increases to over a half [8]. Not surprisingly, evaluations reveal that vehicle crashes comprise a substantial proportion of all work-related fatality figures. For example, data from the Australian National Occupational Health and Safety Commission (NOHSC) showed that approximately 26% of work-related fatalities between 1989-1992 were the result of road crashes [9]. This figure increases to 49% when work-related commuting is included. In the state of Queensland, research has reported that around 37% of all fatal vehicle crashes between the years 1997-2000 involved a commercial vehicle [10]. Workers compensation claims between the years 1996 and 2001 also showed that 203 claims were made for fatal work-related crashes, which represents 47% of all workplace fatal incidents for that period [11].

While the human and societal costs of work-related crashes are serious factors, it appears that financial losses are a major influential factor for both private and government organisations. It has been suggested

that the total cost of work-related crashes in Australia amounts to approximately half a billion dollars each year [8] and the average total insurance cost of a work-related vehicle incident to organisations and society is approximately \$28 000 [12]. While there are obvious costs related to work crashes such as vehicle and property repair costs, there are also many hidden costs including third party costs, workers compensation, medical costs, rehabilitation, customer related costs, increased insurance premiums, administrative costs, legal fees and loss of productivity [13, 14]. Hidden costs are estimated to be somewhere between 8-36 times that of vehicle repair/replacement costs [15]. While it is acknowledged the true figures are currently unclear [11], the available evidence appears to suggest that the direct cost of work-related crashes is only the 'tip of the iceberg' [15]. For example, Seljack and Maddock [16] pointed out that the cost of workers compensation claims amounted to approximately \$17 million in Queensland for work-related crash injury and illness during 1999-2000. Furthermore, out of all occupational incidents, those related to road trauma contribute the most to worker absenteeism [8, 17].

### ***Safety Culture and Behaviours***

Like groups of people, organisations have cultures that broadly influence the behaviours and expectations of their staff [18]. With respect to safety, reasoning for culture change is that the organisation's basic values or assumptions about safety broadly influence the level of effort and the specific plans and initiatives used by that organisation to manage safety [19]. In turn, these activities serve to shape the perceptions held by employees regarding the importance of safety and their expectations regarding the importance of safe work practices, hazard control, incident reporting, and so on. In addition, safety culture is often conceptualised as existing at two levels: organisational structure, including safety policies, management structure, and managerial commitment; and at the individual level, including employees' attitudes and occupational safety practices [20]. When applied to the context of work-related road safety, safety culture encompasses a broad combination of organisational and individual factors such as: fleet safety policies and management commitment to driver and vehicle safety, as well as drivers' shared attitudes, behaviours and norms.

### ***Driving Assessment Tools***

As a result of the considerable burden of road crashes that road crashes have on the community, researchers are focussing on investigating the attitudes and behaviours of drivers' in an attempt to predict road crashes. The Manchester Driver Behaviour Questionnaire (DBQ) [21] is increasingly becoming a popular instrument for investigating the self-reported driving behaviours of motorists [22]. In particular, this tool has been utilised in a number of different areas of driver safety research that includes: age differences in driving behaviour [23], the genetics of driving behaviour [24], cross cultural studies [22] as well as factors contributing to accident involvement [23, 25] and demerit point loss [26]. Modified versions of the DBQ have recently been utilised to measure the driving behaviours of professional drivers [26, 27, 28] to predict crash and offence involvement.

The Driver Attitude Questionnaire (DAQ) [29] has been utilised within a number of different applied settings such as: driver training programs [30], bicycle interventions [31], speed awareness training [32] and fleet programs [27]. The DAQ focuses on four distinct factors that aim to measure respondents' attitudes towards major driving issues, which are: (a) drink driving (b) following closely to other vehicles (c) risky overtaking and (d) speeding.

The Safety Climate Questionnaire (SCQ) is being utilised within road safety arenas, as researchers begin to recognise the importance of an organisation's attitudes towards fleet and road safety issues. In simple terms, "climate" relates to how employees perceive the organisational culture and practice of a company [33], and it is hypothesised that this perception impacts upon the way in which workers ultimately behave at work [34]. In regards to safety climate, a growing body of research is demonstrating a link between safety culture and a variety of outcomes, ranging from vehicle crash rates [35, 36], to injury severity [37].

Finally, the Risk Taking measurement tool is based upon Zuckerman's Sensation Seeking Scale's Thrill and Adventure subscale [38] and measures the propensity for drivers' to take risks when driving a motor vehicle. Examining relationships between risky driving and involvement in crashes can open up the possibility of early identification of those more likely to be involved in crashes [39].

The present research aimed to utilise four driving measurement tools to investigate the relationship between self-reported attitudes, behaviours, crash involvement and demerit point loss. More specifically, the study aimed to:

- a) examine a group of work-related drivers' attitudes and behaviours regarding road safety issues via four measurement tools (i.e., DBQ, DAQ, SCQ & Risk Taking);
- b) investigate the relationship between the sub-factors of the measurement tools and self-reported crash involvement and demerit point loss; and
- c) investigate which attitudinal, behavioural or cultural factors pose the greatest risks to work-related road safety.

## Method

### *Participants*

A total of 4195 individuals from a large Australian company volunteered to participate in the study. The average age of the sample was 43.7yrs (range 18 – 66 yrs). There were 4195 males (88.9 %) and 553 females (11.1%). On average participants had held their licence for 26 years. Participants were located throughout Australia in both urban and rural areas. The sample consisted of approximately equal numbers of office workers,  $n = 2244$ , (46.8 %) and field workers,  $n = 2264$ , (47.2 %), with  $n = 284$ , (5.9 %) respondents not indicating their employment type. If driving is a component of their employment, participants are provided with company owned or leased vehicles. Examination of vehicle types revealed that the largest proportion of the sample reported driving sedans ( $n = 2872$ , 61.2%), followed by station wagons ( $n = 1375$ , 28.69%), vans ( $n = 861$ , 18%), and “customer service vehicles” (CSV) ( $n = 518$ , 11%), with only a small percentage indicating usage of four wheel drive vehicles (other than the “CSV” body type), utes or heavy vehicles. The majority of driving by participants was reported to be within the city  $n = 1988$  (42.4 %), or in the city and on country roads  $n = 1867$  (39.82%), with only 767 participants (16.36%) reporting driving on rural roads. A total of 588 participants reported being involved in a crash while driving for work in the past 12 months.

### *Survey Questionnaire*

#### *Driver Behaviour Questionnaire (DBQ)*

The DBQ is based upon Reason's [21] Generic Error Modelling System (GEMS), which proposes that unsafe behaviour can be divided into two broad categories (i.e. errors and violations). Research has shown consistency in the three factor structure of the scale across different countries including the country of origin, Britain [21, 25], Sweden [40], China [41] and Australia [42]. A modified version of the DBQ was used in the current study that consisted of 20 items and measured three different types of aberrant driving behaviour – errors, highway-code violations and aggressive violations [26, 27]. Questions relating to lapses were omitted due to previous research indicating that this factor is not associated with crash involvement [43]. In addition, modifications to the DBQ were made in order to make the questionnaire more representative of Australian fleet driving conditions [26]. Respondents were required to indicate on a five point scale (1 = never to 5 = nearly all the time) how often they commit each of the errors (8 items), highway-code violations (8 items) aggressive violations (4 items).

#### *Driver Attitude Questionnaire (DAQ)*

The DAQ is based on the Theory of Planned Behaviour (TPB) [44] and an extension of the theory of reasoned action. The DAQ [45] is a 20 item questionnaire that assesses attitudes towards four common traffic violations including drinking and driving, close following (tailgating), dangerous or risky overtaking and speeding. Respondents are required to indicate on a five point likert scale (1 = strongly disagree to 5 = strongly agree) their agreement with statements regarding the appropriateness of various driving behaviours.

#### *Safety Climate Questionnaire – Modified for Drivers (SCQ-MD)*

A 29 item version of the SCQ-MD was utilised in the research project. Minor modifications ensured that the questions related specifically to “work-related driving”. Recent research [46] has found, among other things, a relationship between organisational safety climate perceptions in workers and work-related driving behaviour. Organisational safety climate appears, therefore, to be an important concept in the study of work-related driving behaviour. The SCQ-MD contains 5 sub-factors that aim to measure

perceptions towards fleet safety rules, communication and support, work pressures, adequacy of fleet safety procedure and management commitment. A growing body of research has demonstrated that the SCQ-MD is a reliable tool to measure fleet drivers' perceptions towards the safety climate of an organisation [34, 46, 47].

#### *Risk Taking*

As mentioned previously, the Risk Taking measurement tool is based upon Zuckerman's Sensation Seeking Scale's Thrill and Adventure subscale. Sensation seeking is the tendency to pursue novel and stimulating experiences. Individuals scoring high in sensation seeking have strong positive affective reactions to risky situations and actively pursue such activities [38]. Zuckerman's sensation seeking scale [38] has been widely used in the study of risky behaviour, including driving behaviour. Sensation seeking has been found to be significantly positively correlated with risky driving. In addition, the Thrill and Adventure seeking subscale has also been found to be particularly related to risky driving behaviour [48]. The Risk Taking measurement tool contains 9 questions that aim to measure participants' perceptions in relation to risk taking behaviour. The questions are broadly based upon the Thrill and Adventure subscale with modifications to ensure that they are relevant to an Australian professional driver setting.

#### *Demographic Measures*

A number of socio-demographic questions were included in the questionnaire to determine participants' age, gender, driving history (e.g., years experience, number of traffic offences and crashes) and their weekly driving exposure (e.g., type of car driven, driving hours).

#### *Procedure*

The organisation provided a list of individuals who expressed an interest in participating in the research. A letter of introduction, the study questionnaire and a reply paid envelope were distributed through the company's internal mail system to the participants. In total, 4792 were returned representing a total organisational response rate of 35.7%. The response rate for work-related drivers within the organisation is estimated to be considerably higher. However, due to organisational constraints an accurate response rate for work-related drivers could not be determined.

## **Results**

#### ***Factor Structure and Reliability of the Questionnaires***

The internal consistency of the DBQ, DAQ, SCQ-MD and Risk Taking scores were examined through calculating cronbach's alpha reliability coefficients, and are presented in Table 1.

The SCQ-MD factors, which specifically relate to safety, exhibit the highest level of internal consistency. Similar to previous Australian research [42, 49], and on professional drivers [50], the DBQ factors also appear to exhibit relative internal consistency. In relation to the moderate cronbach's alpha reliability coefficient for the DBQ Aggressive Violations factor (.56), this finding is consistent with recent Australian work-related road safety research that failed to identify distinct DBQ factor structures [51]. Further research is required to determine the reliability of both the Highway-Code Violations and Aggressive Violations factors within an Australian work-related driving setting. In contrast, there has been little research to determine the psychometric properties of the DAQ, and although only moderate, the alpha coefficients are similar to previous research [27].

Table 1 also displays the overall mean scores for the DBQ, DAQ, SCQ-MD and Risk Taking factors. Higher means on the DBQ indicate more deviant driving behaviours, while higher scores on the DAQ and SCQ-MD indicate more appropriate road safety attitudes, and positive perceptions regarding the organisation's road safety culture, respectively. Firstly, an examination of the mean scores reveals that for the DBQ scale, participants were most likely to engage in speeding offences while at work, which was significantly more likely compared to committing driving errors  $F(1, 4195) = 70.73, p < .01$  or aggressive violations  $F(1, 4195) = 83.42, p < .01$ . The results indicate that speeding is the most common form of aberrant behaviour reported by the fleet drivers in the current sample, and similar to previous research on professional drivers [50, 52], speeding remains a major road safety concern [27].

An examination of participants' attitudes (DAQ) revealed respondents perceived following too closely ( $M = 4.00$ ) as unacceptable, however it is noted that the sample also believed it was generally unacceptable to

drink and drive, speed, as well as engage in risky overtaking manoeuvres in some circumstances. However, it is noted the differences between the factors are relatively small and may therefore diminish the practical significance of the findings. In contrast to the self-reported behaviours and attitudes, participants reported that the organisation promoted positive and adequate road safety rules ( $M = 4.14$ ), fostered a commitment to road safety ( $M = 4.18$ ), and were able to communicate and receive support regarding road safety issues ( $M = 3.83$ ). However, it is also noted that participants reported some level of work pressure ( $M = 3.53$ ). These differences between the various questionnaires' factors will be examined further in the following section.

Table 1. Alpha Reliability Coefficients, Means and Standard Deviations of the Measurement Scales

Measurement Scale		Alpha	<i>M</i>	SD
<b>DBQ</b>				
Errors	(8 items)	.78	1.36	.38
Highway Code Violations	(8 items)	.77	1.50	.47
Aggressive Violations	(4 items)	.56	1.38	.43
<b>DAQ</b>				
Alcohol	(5 items)	.67	3.84	.66
Close Following	(5 items)	.55	4.00	.59
Overtaking	(5 items)	.67	3.81	.59
Speeding	(5 items)	.67	3.02	.72
<b>SCQ-MD</b>				
Fleet Safety Rules	(3 items)	.74	4.33	.46
Communication & Support	(8 items)	.89	3.83	.50
Work Pressures	(8 items)	.93	3.53	.18
Adequacy of Procedures	(3 items)	.86	4.14	.43
Management Commitment	(7 items)	.93	4.18	.60
<b>Risk Taking</b>	(9 items)	.88	2.09	.78

#### ***Intercorrelations Between Variables***

An examination was undertaken to determine the bi-variate relationships between the DBQ, DAQ, SCQ-MD, Risk Taking factors as well as socio-demographic variables. As expected, strong relationships were evident between the DAQ factors, with the highest correlation being between close following and risky overtaking ( $r = .69^{**}$ ). That is, those who reported a reluctance to engage in risky overtaking manoeuvres were also unlikely to perceive close following as an acceptable driving behaviour. Similar results were also found between the DBQ factors, with the strongest bi-variate relationship identified between highway code and aggressive violations ( $r = .53^{**}$ ).

In regards to bi-variate relationships between the measures, significant negative correlations were evident between all the DBQ and DAQ subfactors (e.g., behaviours vs attitudes), as those who perceived aberrant driving behaviours such as speeding as serious were subsequently less likely to actually engage in such behaviours over the previous six month period (i.e.,  $r = -.33^{**}$ ). Similar negative correlations were identified between the DBQ and SCQ-MD factors, as the positive work environment which provided fleet safety rules, procedures and support resulted in lower levels of self-reported aberrant driving behaviour. For example, adequate fleet safety rules were negatively correlated with driving errors ( $r = -.21^{**}$ ), highway violations ( $r = -.23^{**}$ ) and aggressive violations ( $r = -.15^{**}$ ). In addition, negative correlations were identified between the Risk Taking and the DAQ and SCQ-MD factors, indicating that those drivers who perceive aberrant driving behaviours as serious (i.e. speeding  $r = -.39^{**}$ ) and/or have safe perception in regards to the safety climate of the organisation, are less likely to engage in risky driving (i.e. Risk Taking). However, a positive relationship was identified between the DBQ factors and the Risk Taking tool, suggesting that drivers who engage in aberrant driving behaviours are also more likely to partake in

risk taking whilst driving. For example, the strongest relationship was between the Risk Taking tool and the DBQ factor Highway-Code Violations ( $r = .46^{**}$ ).

In regards to sample characteristics, a negative relationship was found between age and the Risk Taking and DBQ factors, as older drivers were less likely to engage in risk taking or aberrant driving behaviours as well as report positive attitudes towards road safety, as measured by the DAQ. Finally, participants who drove further distances were less likely to report positive driving attitudes as measured by the DAQ, although this was not necessarily associated with a higher frequency of engagement in aberrant driving behaviours, such as highway-code and aggressive violations as measured by the DBQ. However, making a higher number of driving errors in the last six months was positively associated with self-reported work pressure ( $r = .25^{**}$ ). It is noted that some of the bivariate correlations are quite modest and questions remain regarding the practical, rather than statistical, significance with current industry work-related road safety settings.

### ***Prediction of Work Crashes***

The next part of the study aimed to examine the relationship between participants' driving attitudes and behaviours as measured by the DAQ, DBQ, SCQ-MD, Risk Taking and self-reported work crashes. A total of 588 participants reported being involved in a crash while driving for work in the last year. A logistic regression analysis was performed to examine the contributions of the DAQ factors (e.g., overtaking, speeding, close following and alcohol), DBQ factors (e.g., highway code violations, aggressive violations and errors), SCQ-MD factors (rules, communication, work pressure, procedures and management commitment), Risk Taking factor as well as exposure to driving (e.g., kilometres driven each year & hours driving per week) to the prediction of self-reported crashes in the past 12 months.

Table 2 depicts the variables in each model, the regression coefficients, as well as the Wald and odds ratio values. Self-reported number of kilometres driven each year and hours of driving per week were entered in the first step to examine, as well as control for, the influence of driving exposure before the inclusion of the proposed attitudinal and behavioural factors. As expected, participants who reported a higher level of driving exposure (i.e., klms per year) were most likely to indicate that they had been involved in a work-related crash in the past 12 months,  $p < .001$ .

Next, the DBQ, DAQ, SCQ-MD and Risk Taking factors were entered in the model to assess whether the proposed attitudes and behaviours improved the prediction of crash involvement, over and above, exposure to driving (Step 2). The additional variables collectively were significant, with a chi-square statistic of  $X^2 (13, N = 4645) = 47.59, p = .000$ . The model indicates that participants who reported a higher number of driving errors were most likely to be involved in a work-related crash ( $p = .015$ ). Furthermore, reporting a higher level of work pressure was also predictive of crash involvement ( $p = .025$ ). However, it is noted that while the classification rate was high at 86.7% in both models (after controlling for kilometres driven), the overall model was more significant at predicting drivers who are not involved in crashes, rather than those who reported involvement in traffic accidents (non-crash involvement = 86.7%, crash involvement = 10.0%). Several additional regression models were estimated to determine the sensitivity of the results. A test of the full model with all 14 variables entered together, as well as the two models entered separately, confirmed the same significant predictors (e.g., exposure, errors and work pressure). The inclusion of gender, age and years driving experience did not increase the predictive value of the model. Two factors of exposure, hours per week and km's per week ( $r = .52^{**}$ ), were utilised within the regression model for two primary reasons. Firstly, this is an exploratory study and as such the authors wanted to determine which of the two factors is predictive of work crashes. Secondly, 'driving hours' is not necessarily reflective of 'km's driven' as it does not consider the driving environment (e.g., congested traffic versus open highway).

Table 2. Logistic Regression Analysis of Work Crashes Over a One Year Period as a function of the Modified DBQ, DAQ, SCQ and Risk Taking Scales after Controlling for Exposure

Variables	B	SE	Wald	<i>p</i>	Odds ratio Exp (B)	95% CI	
						Lower	Upper
Step 1							
Hours per week	.11	.04	6.89	.009	1.11	1.02	1.21
Kms per year	.12**	.02	20.90	.000	1.13	1.07	1.19
Model Chi-Square 51.60** (df = 2)							
Step 2							
Hours per week	.07	.04	2.73	.098	1.07	.98	1.17
Kms per year	.11**	.03	14.73	.000	1.12	1.06	1.18
Errors	.33*	.13	5.89	.015	1.38	1.06	1.80
Highway code	.06	.13	.20	.648	1.06	.81	1.38
Aggressive	.11	.12	.76	.384	1.11	.87	1.42
Alcohol	-.04	.08	.31	.576	.96	.83	1.11
Close following	.04	.09	.21	.643	1.04	.87	1.25
Speeding	-.03	.07	.22	.639	.97	.84	1.12
Overtaking	-.03	.09	.09	.762	.96	.83	1.11
Fleet safety rules	.11	.07	2.53	.111	1.12	.97	1.28
Communication	-.09	.08	1.23	.268	.92	.79	1.06
Work pressure	-.16*	.07	5.07	.024	.85	.74	.98
Procedures	-.01	.10	.015	.903	.98	.82	1.19
Management	-.02	.10	.04	.843	.98	.81	1.18
Risk Taking	-.02	.07	.12	.725	.97	.86	1.10
Model Chi-Square 99.19** (df = 15)							
Block Chi-Square 47.59** (df = 13)							

Note. \*  $p < .05$ , \*\* $p < .01$ . CI = Confidence level

### Prediction of Demerit Point Loss

A total of 548 participants reported being involved in traffic infringements (demerit point loss) while driving for work in the last year. Previous research reported that the number of offences, (without regard to their type) seemed to be generally the best predictor of crash involvement [53]. In addition, it was reported that drivers with higher numbers of offences are three to six times more likely to be involved in crashes, although the numerical rates differed widely between the studies identified within the report. Therefore, identifying factors that can predict loss of demerit points may be valuable for developing interventions aimed at reducing crashes. However, this paper revealed that although significant, correlations between crashes and loss of demerit points were relatively small. Therefore, further research is required to determine any link between demerit point loss and crashes within an Australian industry setting.

A range of demographic variables entered into a Logistic Regression Model (similar to Table 2) produced an overall significant result,  $\chi^2(13, N = 4179) = 53.13, p < .001$ . However, amongst the demographic variables, hours of driving per week ( $p = .001$ ), was the only significant predictor of demerit point loss. After inclusion of the assessment tool factors, the logistic regression model indicated that only DBQ factors, specifically errors and aggressive violations, were predictive of incurring offences/demerit point loss within this sample of work-related drivers (i.e. speed and red light cameras). The model indicated that participants who reported a higher number of driving errors ( $p = .009$ ) or report engaging aggressive type driving ( $p = .032$ ) were most likely to commit a driving offence.

### ***Predictors of Highway-Code Violations***

Finally, earlier analyses identified speeding as the most common aberrant driving behaviour engaged in by work-related drivers within the current study. As a result, it was of interest to determine whether any other demographic, attitudinal or behavioural factors are predictive of engaging in highway-code violations, primarily speeding. The modified DBQ highway-code violations factor utilised within current and previous work-related driving research contains a number of questions relating to speeding behaviour [26]. Therefore, a stepwise multiple linear regression analysis was implemented to identify such factors, with the Highway-Code Violations factor of the DBQ acting as the dependent variable. Overall, the model was determined to be highly significant,  $F(13, 4429) = 409.64$ ,  $p < .001$ , adjusted  $R^2 = .54$ .

Firstly, linear regression modelling revealed that the only demographic or work environment variable to predict self-reported highway-code violations was age ( $\beta = -.228$ ,  $p < .001$ ). This result suggests that the older the driver the less likely they are to engage in violations, specifically speeding. Next, the additional measurement tool factors were all entered which revealed the three strongest predictors, with the greatest standardised beta weights, to be aggressive violations ( $\beta = .326$ ,  $p < .001$ ), errors ( $\beta = .281$ ,  $p < .001$ ) and risk taking ( $\beta = .225$ ,  $p < .001$ ). Inclusion of all measurement tool factors into the model accounted for 49% of the highway-code violations variance. In regards to the DBQ factors, results suggest that those who engage in highway-code (primarily speeding) violations are also more likely to engage in other aberrant driving behaviours (e.g., errors and aggressive violations). However, characteristics of the individual (more specifically a possible factor of risk taking) are also predictive of engagement in highway-code behaviours. While some DAQ and SCQ-MD factors were also statistically significant predictors of highway-code violations, such as the SCQ-MD fleet safety rules factor ( $\beta = -.054$ ,  $p < .001$ ) and the DAQ speeding factor ( $\beta = -.086$ ,  $p < .001$ ), overall risk taking, errors and aggressive violations were the most powerful predictors of self-reported highway-code violations, primarily speeding behaviour.

## **Discussion**

Utilising popular self-report driving measurement tools (e.g., DAQ, DBQ, SCQ-MD and Risk Taking), the present study aimed to examine self-reported behaviours and attitudes and predict self-report crash involvement and demerit point loss among a group of Australian work-related drivers.

Firstly, analysis of the measurement tools' internal consistency indicated that the DBQ, SCQ-MD and Risk Taking were moderately robust, with the DBQ and SCQ-MD results similar to previous research that has utilised the questionnaires [47, 49, 50, 54]. However, the DAQ's internal consistency was relatively low, and as the scale has not been extensively validated within the literature, it appears that further research is necessary to determine the psychometric properties of the questionnaire, and its subsequent usefulness within fleet research.

Secondly, examination of the mean scores for the DBQ, DAQ, SCQ-MD and Risk Taking factors revealed that participants generally reported positive attitudes and behaviours towards road safety. Similar to previous research in relation to driver attitudes [27, 32], respondents reported close following and drink driving as the least acceptable driving behaviours. Participants also reported risky overtaking practices were an additional unacceptable behaviour, while attitudes towards speeding were more lenient. This finding is consistent with research that has indicated speeding is the most common form of aberrant driving behaviour reported by motorists [25, 26, 55]. In regards to the organisation's safety climate, work pressures were identified as a potential factor impacting on employees' safe driving behaviour.

In regards to the relationship between the measurement tools, significant associations were identified between attitudes and the corresponding behaviours. That is, participants who agreed with the seriousness of the specified aberrant driving behaviours were less likely to report engaging in such behaviours over the past six months (e.g., DBQ highway-code factor). Furthermore, the bi-variate correlations also provided a preliminary indication that the culture of the organisation, in particular the direction provided by the management team, is associated with driving behaviours. For example, the collected data generally indicates that the current organisation provided relatively clear fleet safety rules, appropriate communication and support as well as strong management commitment, which was negatively associated with engaging in the aberrant driving behaviours. While only preliminary, the results suggest that the "safety climate" of a fleet organisation has the potential to influence the driving



outcomes exhibited by employees. It should be noted that in relation to work crashes only the work pressures sub-factor was significant. However, similar to previous research [34] if an intervention strategy were implemented in an attempt to decrease crashes and generally improve work-related road safety within an organisation, work pressures may be an important factor to consider. In addition, there were strong correlations between the Risk Taking and DBQ factors, especially the highway-code violations factor. This indicates that drivers who engage in aberrant driving behaviours are also more likely to partake in risk taking whilst driving.

Despite the positive appraisal regarding the safety climate of the organisation, 588 participants reported being involved in a work-related incident and 548 participants reported driving offences (demerit point loss) in the past 12 months. In regards to the prediction of self-reported crash involvement while driving for work purposes, a number of key factors were identified. Firstly, it appears that greater exposure to the road, such as driving more kilometres per annum, increases the likelihood that drivers will be involved in a crash. While not surprising, the results may provide an opportunity for fleet managers to identify those at risk of crash involvement through exposure, and ensure such drivers receive appropriate interventions and supervision to reduce the likelihood of being involved in an accident. Secondly, the logistic regression analyses indicated that making a higher number of errors as well as reporting higher levels of work pressure were both predictive of work crashes. Interestingly, these two predictive variables were also correlated at a bivariate level, as those who reported increased work pressure were also more likely to report committing a higher number of driving errors in the past six months ( $r = .25^{**}$ ). Further research appears necessary to determine whether there is a causal link between work pressures and committing errors, as previous research suggests fatigue related issues are a contributor to crash involvement [14]. However, it is also noted that the overall model was not very effective at predicting those most likely to be involved in work-related crashes. While to some extent this may be expected as there is arguably a plethora of factors that may influence both driving performance and the likelihood of crash involvement, from a research perspective, the findings indicate that further research is required to determine the efficacy of current assessment tools to identify “at risk” drivers.

In relation to driving offences, the logistic regression model indicated that only the DBQ factors, errors and aggressive violations, were predictive of incurring offences/demerit point loss within this sample of work-related drivers. The model indicated that participants who reported a higher number of driving errors or partake in aggressive type driving acts were most likely to be apprehended for a driving offence. In addition, amongst the demographic variables, hours of driving per week, was the only significant predictor of demerit point loss. It is interesting to contrast this finding with the crash prediction analysis, which identified “kilometres per year” as a significant predictor of crashes, rather than its covariate “driving hours”. These contrasts may be due to the nature of the driving environments. The Field vehicles doing higher kilometres per year are likely to be spending large amounts of driving time on highways and rural roads with a relatively high crash risk due to exposure, but a relatively low risk of being detected speeding or running a red light, due to relatively low levels of speed enforcement and very few traffic lights on these roads. In comparison, drivers working in city environments would be doing relative long hours of driving, but lower kilometres per annum. These city driving environments have relatively high levels of speed enforcement and red light cameras, leading to a higher probability of receiving speeding or red light violation infringements.

Next, a potential fleet “speeding culture” was identified from univariate analysis. For example, drivers were most likely to report engaging in speeding behaviours and also believed that speeding was a more acceptable behaviour. In addition, a positive relationship was identified between the DBQ factors and the Risk Taking factor, suggesting that drivers who engage in aberrant driving behaviours are also more likely to partake in risk taking whilst driving. For example, the strongest relationship was between Risk Taking and the DBQ factor Highway-Code Violations. To further investigate the prediction of aberrant driving behaviours, a linear regression analysis was conducted. Interestingly, the only demographic variable to significantly predict aberrant driving behaviour (specifically highway-code violations) was age, indicating that younger drivers are more likely to engage in aberrant driving behaviour. Therefore, interventions addressing such behaviour could be initially targeted toward younger work-related drivers. However, the Risk Taking factor was one of the strongest predictors of aberrant driving behaviour, in addition to the DBQ factors, errors and aggressive violations. In regards to Risk Taking, the results are important because they suggest that risk takers drive in a manner that is consistent with their personality [56]. Therefore, a measure of drivers’ tendency toward risk taking could help predict their aberrant driving behaviour. This

information should be of value given that aberrant driving behaviour (primarily speeding) has a clear relationship with crash involvement as well as the severity of crashes [57]. In addition, the results suggest that drivers engaging in other aberrant driving behaviours (e.g., errors and aggressive violations) are also more likely to commit highway-code violations (e.g. speeding) whilst driving for work. Within the current study, univariate, bivariate and multivariate analyses indicated that speeding has the potential to be a major road safety issue for organisations. Therefore, the identification of speeding as a primary work-related road safety risk factor enables organisations' to direct resources and finances targeting such behaviours towards high risk groups. This process may lead to the development of targeted interventions aimed at reducing the likelihood of a work-related crash or offence before the event occurs, rather than on the traditional post hoc basis [27]. Further, research is required to develop a measurement tool that can accurately and reliably measure speeding behaviour and associated issues regarding time pressures.

Finally, study results identified the DBQ errors sub-factor as a significant predictor of work-related crashes, offences and speeding behaviour, while the DBQ aggressive violations sub-factor was identified as a significant predictor of both offences and speeding behaviour. In addition, the Risk Taking factor was significant in predicting speeding behaviour but not crashes or offences. Taken together, the DBQ assessment tool is identified as a valuable tool for assessing work-related driver behaviour, crashes and demerit point loss. Furthermore, current analysis utilising the Risk Taking assessment tool suggests that risk taking maybe an effective predictor of work-related driver behaviour, especially speeding. However, further research is required to assess the reliability and validity of the scale for the Australian setting.

#### *Limitations*

Some limitations should be borne in mind when interpreting the results of this study. The response rate of participants was relatively low, but consistent with previous research that has attempted to investigate fleet drivers [26, 52]. In relation to the study sample, there was an under representation of female drivers, younger drivers, and rural drivers. However, similar to previous work-related road safety research in Australia [26, 27, 28, 51, 52] the majority of participants, especially field type workers/drivers, are older male drivers (average age between 40 and 50 years) and primarily drive/work in city/urban areas. Concerns remain regarding the reliability of the self-reported data, such as the propensity of professional drivers to provide socially desirable responses. Further research is also required to establish the reliability and validity of the scales for the Australian setting, especially the psychometric properties of the DAQ. Finally, it is also noted that a number of additional factors not examined in the current study, both personal and environmental, may influence as well as cause a vehicle-crash (e.g., fatigue).

#### **Conclusion**

The results may prove to have direct implications for work-related road safety interventions, not only through monitoring the driving performance of employees and the corresponding organisational factors (e.g., the level of perceived work pressure), but also through proactive measures to reduce the likelihood and frequency of work-related crashes, offences and aberrant driving behaviours. The study identified aberrant driving behaviour as an important work-related road safety problem and suggests that a potential "speeding culture" exists within the organisation. Identification of the extent of this aberrant driving behaviour provides an opportunity for the organisation to specifically target interventions addressing speeding behaviour in general and also with high risk groups. Given the tremendous personal and economic cost of work-related vehicle crashes in Australia, further research that endeavours to identify an appropriate balance between productivity and personal driver safety within industry settings may prove beneficial at a number of levels.

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