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Article

An Engineering or Behavioural Approach? A Study into Employee's Perceptions Regarding the Effectiveness of Occupational Road Safety Initiatives

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Abstract

Background and Aims: Considerable variation has been documented with fleet safety interventions' abilities to create lasting behavioural change, and research has neglected to consider employees' perceptions regarding the effectiveness of fleet interventions. This is a critical oversight as employees' beliefs and acceptance levels (as well as the perceived organisational commitment to safety) can ultimately influence levels of effectiveness, and this study aimed to examine such perceptions in Australian fleet settings. *Method:* 679 employees sourced from four Australian organisations completed a safety climate questionnaire as well as provided perspectives about the effectiveness of 35 different safety initiatives. *Results:* Countermeasures that were perceived as most effective were a mix of human and engineering-based approaches: (a) purchasing safer vehicles, (b) investigating serious vehicle incidents and (c) practical driver skills training. In contrast, least effective countermeasures were considered to be: (a) signing a promise card, (b) advertising a company's phone number on the back of cars for complaints and compliments and (c) communicating cost benefits of road safety to employees. No significant differences in employee perceptions were identified based on age, gender, employees' self-reported crash involvement or employees' self-reported traffic infringement history. Perceptions of safety climate were identified to be "moderate" but were not linked to self-reported crash or traffic infringement history. However, higher levels of safety climate were positively correlated with perceived effectiveness of some interventions. *Conclusion*: Taken together, employees believed occupational road safety risks could best be managed by the employer by implementing a combination of engineering and human resource initiatives to enhance road safety. This paper will further outline the key findings in regards to practice as well as provide direction for future research.

Keywords: safety culture; climate; occupational road safety; interventions.

1. Introduction

Compared to general motorists, a relatively small body of research has focused on fleet drivers, particularly individuals who drive company sponsored vehicles [1-4]. This may be considered surprising given that professional drivers not only have different driving demands, but they also have higher exposure to risk [5] and are disproportionately represented in crash statistics. In fact, occupational driving crashes are the most common form of injury or death in Australian workplaces [6], with 40% of all worker fatalities over the past 11 years (2003-2013) resulting from vehicle collisions [7]. This effect is not confined to Australia, but rather, similar findings have been reported in the United Kingdom [8] and in the United States [9]. The largest proportion of the research has been directed towards examining fleet drivers' self-reported driving behaviours, which is usually measured via the Driver Behaviour Questionnaire [10]. This research has demonstrated that company drivers have a greater risk of crash involvement [2, 3], due not only to higher levels of exposure to the road environment, but also as a result of time and scheduling pressures and other distractions [11]. This has resulted in a growing view expressed both in industry and the corresponding road safety literature that there is a need to create a proactive "fleet safety culture" that has a strong foundation based on corporate policies, processes and procedures [12].

Interventions

Within Australia, organisational intervention strategies have historically been applied in a "post hoc" manner due to an increase in numbers or severity of work-related vehicle crashes or incidents [13]. That is, most organisational intervention strategies have historically been implemented in reaction to an increase in numbers or severity of work-related vehicle crashes or incidents [13] and fail to proactively address problems or incidents before they occur. Additionally, organisations have traditionally adopted a "one size fits all" approach to intervention strategies that often involves an overreliance on driver training, generally based on enhancing driver skills and not targeting specific driver behaviours or organisational influences [14]. However, some research has been conducted into the effectiveness of three predominant categories of fleet interventions, briefly reviewed below.

Driver Training: The effectiveness of driver training in fleet settings remains relatively unknown, despite it being the most widely implemented fleet intervention [12, 6]. Preliminary research provided limited evidence of effectiveness [15] as it has been suggested that the approach focuses too much on skill improvement at the expense of judgement and decision-making [16]. Rowland, Wishart and Davey [17] argued that an emphasis on strategies to improve the driving skills of drivers reinforces the perceptions of

organisational management that the driver, more specifically a lack of driver skills and ability, is primarily to "blame" for work-related incidents/crashes. Nevertheless, research on general motorists has demonstrated the approach can improve driving skill if it involves formal instruction and extensive practice [18, 19].

Organisational Interventions: Advancements in Occupational Health and Safety legislative frameworks have also resulted in an increasing presence of employer obligations in the workplace [6]. This has subsequently enhanced the focus on driver safety management approaches [6]. Newnam and Watson [20] categorised these risk management approaches into: (a) crash reporting databases and (b) driver recruitment and training. While the utilisation of crash databases is useful in regards to benchmarking, the approach is often reactive and is of little use to develop proactive interventions [14]. Driver recruitment processes often involve confirming that the applicant has a valid licence and collecting information about driving history [20], which arguably should also be undertaken at on-going intervals throughout an employee's contract.

Behaviour Modification: The use of incentives has also proven popular within fleet settings, with many of the approaches being modelled off operant conditioning e.g., providing incentives. Some preliminary research has indicated there is merit in the approach for reducing crashes [21] as well as seat belt usage [22]. Safety awareness programs have also been trialed, and have proven effective but outcome measures are reliant upon self-reported data [23].

Organisational fleet safety interventions are not limited only to the above approaches, and some interventions are multimodal in nature and thus contain different elements. For example, a range of risk management initiatives have been introduced in many motorised countries (including Australia, New Zealand, the United States of America, Ireland, Sweden and the United Kingdom) that include: management education and awareness; policies relating to the management of journeys, drivers and vehicles; safe vehicle selection and maintenance; driver training; driver monitoring; awareness campaigns; risk assessments; post-incident investigations; assessments of health and fitness to operate vehicles; conferences, seminars and workshops; incident data recording; safe driving awards; group discussions; competency based licence testing; and programs focussing on vehicle maintenance, fatigue management, driving hours, and driver health [24, 25]. Banks et al. [26] conducted a document review of empirical studies pertaining to occupational road safety initiatives. From the 19 initiatives reviewed, only six initiatives were found to be positively

associated with occupational road safety benefits (e.g., reductions in crashes or incidents) both during and after the intervention period [25]. These were: a pay rise; driver training; group discussions; enlisting employees as community road safety change agents; safety reminders; and group and individual rewards. However, it should be noted that quantifying the level of effectiveness has yet to be undertaken. While others have argued that a more holistic approach is necessary that addresses a range of risk factors [14]. More specifically, this could include the systematic identification and management of the risks associated with fleet drivers (e.g., attitudes and behaviours), development of appropriate intervention/improvement strategies as well as maintaining continuous monitoring and review of the risks [17]. Furthermore, it has also been suggested that theoretical development in the work-related driving arena has been limited (and similar to the application of interventions), has been anecdotal and data driven [20]. Given the importance of theory in creating behavioural change, such an omission within the fleet safety arena could be a significant oversight.

Importantly, there is some preliminary evidence that indicates community perception of road safety countermeasures do not align with evidence, but rather, appear to suffer from a misunderstanding of behaviour change principles and crash causation [27]. While this research has not been extended to consider occupational road safety, the underlying principle of misalignment between perception and reality has similar implications for fleet safety. More specifically, there may be a disconnect between perceptions of the effectiveness of fleet interventions (as well as the subsequent implementation of initiatives) and actual empirical evidence regarding the efficacy of countermeasures to improve road safety. Furthermore, while previous research has focused heavily on drivers' perceptions of safety [28] as well as self-reported attitudes and behaviours [29], it has generally neglected drivers' perceptions regarding the effectiveness of different fleet interventions. This may prove to be a significant oversight, as research has suggested that employees' beliefs may facilitate or act as a barrier when implementing organisational initiatives [30]. It may yet be proven that individuals are more likely to accept initiatives that they believe will assist them in achieving a goal and to resist initiatives that they believe have limited effectiveness and/or are not appropriate in their organisation [26]. More broadly, the impact of attitudes on behaviour is well documented within the Theory of Planned Behaviour [31] and the powerful influence of attitudes as well as expectations is no more clearly evidenced than in the placebo effect [32]. Furthermore, positive attitudes towards an initiative have been proven to increase usage [33] and it may yet be proven that the limited effectiveness of in-vehicle monitoring systems for teenager drivers [34, 35] is related to low levels of acceptance.

Safety Culture and Climate

The concept of "safety culture and climate" underpins many organizational interventions to improve worker safety. There is some evidence that creating a strong "safety culture" can have a positive effect on improving road safety by reducing fleet collisions [21, 28, 36], although it is also noted that traffic safety culture is a relatively new concept and there is no consensus regarding the nature of the concept nor how it should be defined [37]. The concept of safety culture first emerged in the International Nuclear Safety Advisory Group's (INSAG) report on the 1986 Chernobyl nuclear power plant disaster, which indicated that a lack of safety culture contributed to the incident. A complete review into the evolution and development of safety culture is beyond the scope of the current paper [see 38, 39], but in its simplest terms, the concept may be defined as "the assembly of underlying assumptions, beliefs, values and attitudes shared by members of an organisation, which interact with an organisation's structures and systems and the broader contextual setting to result in those external, readily-visible, practices that influence safety" [40, p77]. The concept has a lengthy history of application in organisational safety over the past 25 years, but it has only recently emerged in the traffic safety literature [40]. Nevertheless, preliminary research has provided positive results regarding the influence of safety culture. For example, Öz et al. [5] explored the self-reported driving behaviours of 230 male professional drivers and reported those with low work orientation scores (e.g., culture) reported significantly more DBQ related-violations than those with high scores for work orientation.

A further extension of the safety culture concept is that of *safety climate*, which refers to employees' shared perceptions of management's commitment and operations with regards to fleet safety practices, policies and procedures [28, 41]. As such, fleet safety climate forms part of the broader concept of safety culture, but focuses primarily on workers' perceptions and thus represents a psychological construct [28]. Preliminary research has identified a number of general dimensions that may impact fleet safety climate including: management commitment; work demands and pressure; trusting relationships including communication and support; appropriateness of safety rules as well as safety training [28, 41, 42]. In regards to impacts on safety performance, there is some evidence for a relationship between safety climate and safety outcomes in regards to: self-reported current driver behaviour and future driving intentions at work [43]; incident rates [44]; and self-reported safety behaviours and injury outcomes [45]. For example, Wills et al. [43] found that both individual factors (e.g., safety attitudes) and organisational factors (e.g., safety climate perceptions) influenced current driving behaviours as well as future driving intentions. Newnam et al. [46] also reported that among a sample of fleet drivers, both individual factors and organisational safety values can influence safety outcomes. Despite this research, it has been suggested that few theoretical or conceptual advances have been made within the fleet safety domain [20], and research rarely uses such frameworks to explore work-related driving issues. Nevertheless, given the

possible links between safety climate and safety outcomes, it is suggested that fleet safety climate may be related to occupational road safety outcomes (e.g., improved safety), and thus worthy of further exploration [47].

Taken together, empirical evidence is lacking into the effectiveness of a range of fleet interventions as well as how theoretical constructs such as safety culture and climate can be combined with organisational initiatives to enhance safety outcomes. As noted above, research has neglected drivers' perceptions regarding the effectiveness of interventions despite evidence that indicates employees' beliefs can influence the safety outcomes of countermeasures. As a result, this study aims to examine employees' perceptions regarding various occupational road safety initiatives and explore what factors influence such perceptions.

2. Experimental Section

A total of 679 employees sourced from four Australian organisations completed an on-line questionnaire. Participation was confidential and anonymous. The organisations included private and public, profit and not-for-profit organisations containing vehicle fleets. These organisations were responsible for a combined workforce of approximately 42,000 and a combined fleet of approximately 19,000, which operated in both rural and urban environments. A convenience sampling approach was utilised with a minimum of 100 volunteering participants being sampled from each of the four organisations. Participants ranged in age from 18 years to 65 years ($\underline{M}$ = 42, $\underline{SD}$ = 11). A relatively even distribution of male (58%) and female (42%) participants was achieved. Participants reported regularly driving a vehicle for occupational purposes e.g., 80% on a daily basis. Crash involvement and demerit point history (e.g., fines) were examined via participants reported frequency of such events over the past 12 months. The largest proportion of the sample had not been involved in a crash (84.5%, n = 574), with 9.6% (n = 65) being involved in one crash and 1.9% (n = 13) being involved in more than one crash. In regards to fines, 87.5% (n = 594) had not received a fine in the last year, while 7.1% (n = 48) received one fine and 1.5% (n = 10) received more than one fine.

A questionnaire was developed that required participants to rate 35 fleet safety-based initiatives in regards to how effective they perceived they would be in improving road safety in their organisation. Initiatives were selected based upon: (a) a review of interventions proposed to be best practice in industry reports [6, 24, 25, 48, 49, 50]; and (b) initiatives that had been previously empirically evaluated [51]. However, the nominated interventions were not all implemented across the four interventions. Identified initiatives that have been previously researched included: group discussions to identify safety problems and brainstorm solutions [21], safe driving goal setting, [52] signing a promise card commitment to drive safely [53], monitoring driver behaviour with in-car data recorders [54], and encouraging self-monitoring of driving behaviour [55]. The questionnaire

was piloted with both 15 managers and 15 employees. Participants were required to rate initiatives on a five-point Likert scale ranging from very ineffective to very effective. The descriptions of the initiatives used in the questionnaire can be viewed in the results section in Table 1.

A 36 item fleet safety climate scale developed in previous research [41] was also utilised. The items were consistent with existing fleet safety climate measures such as the Safety Climate Questionnaire – Modified for Drivers [SCQ-MD] which has previously been validated with industry samples [43]. Participants' responses to the items required them to indicate how much they thought the practices applied to their organisation. Items were measured using a five-point scale ranging from one representing never to five representing always. All factors were calculated such that higher scores indicated safer perceptions.

3. Results and Discussion

3.1 Perceived Effectiveness

Descriptive analysis revealed that the initiatives perceived by employees to be most effective in managing occupational road risks were multifaceted. The top five initiatives were considered to be: (a) making vehicle safety features standard, (b) practical driver training skills, (c) investigation of serious driver vehicle crashes and incidents, (d) making cruise control a standard vehicle feature and (e) targeting safety assistance to high risk drivers (see Table 1). As a result, the countermeasures perceived to be most effective consisted of either technological approaches or a focus on human factors. However, it is noteworthy that only "making vehicle safety features standard" reached a mean score above 4 indicating consensus that the approach was "effective." Additionally, there has yet to be a cumulative body of evidence that indicates the initiatives (particularly practical driver training skills) actually improves fleet safety. Between groups analysis revealed no significant differences between the three highest ranked items, although a top ranked item (e.g., making vehicles safer) was ranked significantly higher than the fifth ranked item (e.g., targeting safety assistance) $t(679) = 8.19$, $p < .01$. In contrast, the least effective initiatives were considered to be: (a) signing a promise card, (b) advertising company phone numbers on vehicles, (c) consideration of driving competence in staff recruitment, (d) communicating cost benefits of road safety and (e) presenting comparisons of vehicle incident statistics between depots. No significant differences in employee perceptions were identified based on age, affiliated organisation, gender, employees' self-reported crash involvement or employees' self-reported traffic infringement history.

Table 1 - Employee perceptions of initiative effectiveness

Occupational Road Safety Initiative	Mean	SD
Making vehicle safety features standard e.g. passenger airbags	4.02	1.11
Practical driver skills training	3.94	1.25
Investigation of serious vehicle incidents	3.89	1.09

Making cruise control a standard vehicle feature	3.69	1.23
Targeting safety assistance to high risk drivers	3.66	1.14
Marking low visibility walls and objects with hazard colours	3.60	1.21
Recording vehicle incidents and identifying high risk employees and vehicles	3.59	1.16
Assessing competency before being cleared to operate vehicles in difficult areas	3.57	1.22
Medical screening for problems that will affect driving e.g. vision	3.53	1.25
Journey planning to avoid high risk situations e.g. animals at dusk	3.49	1.19
Vehicle inductions for all drivers	3.48	1.22
Awareness communication on work related road risks e.g. emails, posters	3.46	1.01
Employee input in selection of vehicles	3.44	1.27
Individual incentives for safe driving	3.44	1.27
Presenting genuine personal stories about serious crashes in your organisation	3.43	1.19
Making 'lights on' during driving a standard vehicle feature	3.39	1.30
Documenting vehicle maintenance	3.39	1.10
Provision of driver safety information	3.38	1.02
Checking driver's licences are current every 12 months	3.30	1.35
Group incentives for safe driving	3.27	1.21
Individual feedback on driving behaviour	3.27	1.13
Development and promotion of work related road safety policy	3.25	1.01
Including driving behaviour in performance assessments	3.21	1.21
Safe driving goal setting	3.15	1.10
Encouraging self-monitoring of driving behaviour	3.09	1.06
Individual consequences for unsafe driving	3.07	1.03
Making speed-limiters a standard vehicle feature	3.06	1.36
Group discussions to identify safety problems and brainstorm solutions	3.00	1.12
Group feedback on driving behaviour	3.00	1.17
Monitor driver behaviour with in-car data recorders	2.93	1.32
Presenting comparisons of vehicle incident statistics between depots	2.92	1.20
Communicating cost benefits of road safety e.g. fuel efficiency	2.87	1.13
Consideration of driving competency in staff selection process	2.87	1.18
Advertising organisations phone number on vehicles for complaints & compliments	2.81	1.36
Signing a promise card commitment to drive safely	2.37	1.17

3.2 Safety Climate

A factor analysis of the Fleet safety climate scale was implemented to determine the factor structure of the scale, which extracted five factors that were: (a) management commitment; (b) work demands; (c) trust; (d) appropriateness of rules; and (e) communication. The observed reliability coefficients for each of the factors were above the acceptable cut-off level of .70. Mean and standard deviation scores were calculated for the overall fleet safety climate questionnaire as well as for each of the five extracted factors. The mean overall fleet safety climate score was 3.33 (SD = 0.67), which on a five point likert scale, suggests a perceived "moderate" level of organisational support for safety. Mean scores remained relatively consistent across the five factors, which are presented in Table 2. Factor Five - communication (M = 3.27, SD = 0.80).

Table 2. Climate Factors

Factor	Item Examples	*M*	*SD*

Management commitment	*Management are committed to motor vehicle safety* *Management are committed to driver safety*	3.47	.88
Work demands	*Safety rules relating to the use of motor vehicles are followed even when a job is rushed*	3.13	.89
Trusting Relationships	*Employees trust management* *Management trust employees*	3.15	.89
Appropriateness of Rules	*Safety rules relating to the use of motor vehicles are always practical*	3.55	.72
Communication	*An effective documentation management system ensures the availability of safety procedures relating to the use of motor vehicles*	3.27	.88

3.3 Safety Performance

A series of analyses were undertaken to determine the impact of safety climate and perceived initiative effectiveness on driving performance (e.g., crashes and fines), as climate has been proposed to influence safety outcomes [28]. In regards to aberrant driving behaviours, no significant differences were identified between crash involvement or incurring fines and self-reported safety climate. This may be considered unsurprising given the small number of employees who reported being involved in a crash or receiving a fine, which may in part be dependent upon the 12 month time period. Pearson's correlations revealed that higher perceptions of management commitment were positively associated with awareness communication regarding risks (r = .20**), setting a goal of safe driving (r = .21**) and promotion of road safety policy (r = .21**). Higher reports of work demands was positively associated with including driver behaviour in performance assessments (r = .24**) and enforcing individual consequences for unsafe driving (r = .22**). For trusting relationships, communicating the benefits of cost benefits was positively associated with this factor (r = .21**) and signing promise cards (r = .19**). Having appropriate rules was positively correlated with performance assessments (r = .17**) while communication was related to promoting awareness (r = .20**), goal setting (r = 2.23**) and having safety policies (r = .21**). Not surprisingly, higher inter-correlations were identified between the five safety climate factors e.g., communication and management commitment (r = .78**).

4. Conclusions

This study aimed to examine employees' perceptions regarding various occupational road safety initiatives and explore what factors influence such perceptions. In regards to perceptions, a range of engineering/technology as well as human factors initiatives were considered moderately effective, such as purchasing safer vehicles, investigating serious vehicle incidents and practical driver skills training. It is noteworthy that research has yet to conclusively determine whether such approaches are in fact effective at improving road safety. More specifically, while utilising safer vehicles and investigating incidents makes intuitive sense, research has yet to demonstrate that increasing driver training skills and targeting safety assistance for high risk drivers actually improves driving outcomes. Of interest is that some of the initiatives that were considered least effective, were countermeasures currently widely undertaken in Australia, such as "advertising company phone numbers on vehicles". Additionally, monitoring driver behaviour with in-car data recorders was considered the sixth least effective initiative, which is surprising given that in-vehicle monitoring systems are: (a) being increasingly embraced within the fleet industry and (b) beginning to produce positive results [56]. In regards to the latter, a number of preliminary trials have reported improvements in fleet safety [57] including a reduction in crashes [54, 58, 59, 60]. This finding may be explained by the human propensity to display negative attitudes towards interventions they have little exposure to [61]. Further research is required into fleet drivers' acceptance of installing technology in vehicles, as research is identifying that user acceptance is a multifaceted concept that can influence program success e.g., Technology Acceptance Model [62]. The lack of research into user acceptance of in-vehicle systems is a critical oversight given the increasing implementation of the technology in Australia.

In regards to the influence of safety climate on perceptions of initiative effectiveness as well as self-reported aberrant driving behaviours, the findings were mixed. On the one hand, expected correlations were found between factor loadings of safety climate and the perceived effectiveness of initiatives e.g., trusting relationships and communicating cost benefits of safety to employees. On the other hand, a clear link was not identified between safety climate and self-reported crash involvement or incurring fines. This could be due to the small percentage of the sample who were actually involved in such incidents in the 12 months, or the finding could also reflect on-going difficulties conceptualising and operationalising safety culture and climate. Additional limitations associated with this study include the accuracy of self-report data, including the tenuous link between self-reported behaviours and other objective measures. On-going difficulties associated with measuring the nature and impact of safety culture are well documented in the literature [38, 40], yet the concept is increasingly being utilised to direct the implementation of safety initiatives [40]. Finally, further research is needed to determine the organisational processes that both facilitate and maximise a collective motivation to improve safety. Preliminary research has

demonstrated that institutional forces can positively influence employees' general perceptions of initiatives in the workplace [63] and employee's perceived effectiveness of interventions actually impacts upon safety outcomes [64]. Taken together, continued research to both identify and enhance the processes that increase intervention acceptance and the corresponding effectiveness of actual fleet interventions can only assist in reducing the burden of road crashes. It is also noted that the effectiveness of interventions can be measured in different ways, and future research may benefit from undertaking a multi-modal approach to examine the impact of interventions e.g., self-report, incident reports, etc. This research has demonstrated that while the relationship between perceived effectiveness of interventions and safety climate is not always clear, workers may be willing to participate in a range of engineering and human-factor initiatives.

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Conflict of Interest

The authors declare no conflict of interest

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