Accident Analysis and Prevention 58 (2013) 26–34

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

The effect of external non-driving factors, payment type and waiting and queuing on fatigue in long distance trucking

Ann Williamson *, Rena Friswell

Transport and Road Safety Research, School of Aviation, University of New South Wales, Sydney, NSW 2052, Australia

ARTICLE INFO

Article history:
Received 10 October 2012
Received in revised form 8 April 2013
Accepted 9 April 2013

Keywords:
Truck driver
Long distance road transport
Payment system
Queuing
Driver fatigue

ABSTRACT

Introduction: The aim of this study was to explore the effects of external influences on long distance trucking, in particular, incentive-based remuneration systems and the need to wait or queue to load or unload on driver experiences of fatigue.
Methods: Long distance truck drivers ($n = 475$) were recruited at truck rest stops on the major transport corridors within New South Wales, Australia and asked to complete a survey by self-administration or interview. The survey covered demographics, usual working arrangements, details of the last trip and safety outcomes including fatigue experiences.
Results: On average drivers' last trip was over 2000 km and took 21.5 h to complete with an additional 6 h of non-driving work. Incentive payments were associated with longer working hours, greater distances driven and higher fatigue for more drivers. Drivers required to wait in queues did significantly more non-driving work and experienced fatigue more often than those who did not. Drivers who were not paid to wait did the longest trips with average weekly hours above the legal working hours limits, had the highest levels of fatigue and the highest levels of interference by work with family life. In contrast, drivers who were paid to wait did significantly less work with shorter usual hours and shorter last trips. Multivariate analysis showed that incentive-based payment and unpaid waiting in queues were significant predictors of driver fatigue.
Conclusions: The findings suggest that mandating payment of drivers for non-driving work including waiting would reduce the amount of non-driving work required for drivers and reduce weekly hours of work. In turn this would reduce driver fatigue and safety risk as well as enhancing the efficiency of the long distance road transport industry.

1. Introduction

Fatigue is a major risk factor for long distance truck drivers. It has been reported to contribute in up to 31% of single vehicle fatal truck crashes in one early US study (National Transportation Safety Board, 1990). A more recent European crash investigation study reported 18.6% of fatal and non-fatal single vehicle truck crashes involved fatigue/falling asleep but fatigue crashes were overrepresented among fatal crashes (International Road Transport Union (IRU), 2007). As well as a direct road safety role in crashes, fatigue affects the daily working life of truck drivers as indicated by survey results in which fatigue is reported to be a significant problem for a notable proportion of drivers (Williamson et al., 1992, 2001; AMR Interactive, 2007). There is also evidence of indirect effects of fatigue from analysis of the predictors of stimulant use in truck drivers that showed a clear link between problems in managing fatigue and stimulant use (Williamson, 2007).

Fatigue in this occupational group can be most obviously linked to the well-established causes of short sleep opportunities and long and irregular working hours (Williamson et al., 2011). In Australia, as in many countries, there are working hours regulations for long distance trucking, however the nature of the operational requirements of long distance trucking in many countries presents a challenge for reducing fatigue in this occupation. Long distances, with few appropriate places to stop and often tight delivery schedules can make it difficult to achieve good fatigue risk management in this industry because these characteristics are difficult to change. There are a number of other characteristics of the long distance trucking that are likely to contribute to fatigue but which can be changed. Clearly, we need to know more about these characteristics and, where they are shown to be linked with increasing fatigue for truck drivers, change them.

There is good evidence across a range of countries that pressures that increase the hours that drivers work increase both the reported fatigue and crash risk. An on-road study of truck drivers in Sweden

* Corresponding author. Tel.: +61 2 9385 4599; fax: +61 2 9385 6637.
E-mail addresses: a.williamson@unsw.edu.au (A. Williamson), r.friswell@unsw.edu.au (R. Friswell).

0001-4575/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.aap.2013.04.017

showed that total work hours was the best predictor of sleepiness changes in EEG across a night drive (Kecklund and Akerstedt, 1993). Similarly, Williamson et al. (1996) showed that subjective fatigue increased with duration of trip for Australian truck drivers and McCartt et al. (2000) showed that US truck drivers who had long work hours with limited off-duty time were significantly more likely to report having fallen asleep at the wheel. A study of truck drivers in Crete also showed that greater non-driving work hours predicted both falling asleep at the wheel and crash risk (Tzamboulaka et al., 2005). Other studies have also shown that total driving time has an effect on crash or sleep risk among truck and other drivers in addition to factors like time of day or driving experience (Harris, 1977; Lisper et al., 1986; Hamelin, 1987; Lin et al., 1993).

Overall, there has been comparatively little research on the influence of factors relating to external, non-driving factors on fatigue and crash risk in the long distance road transport industry. This is in spite of the fact that a study of working conditions for truck drivers working at Israeli ports found that working conditions independent of sleep factors were the major risk factors for fatigue while driving, falling asleep at the wheel and crashes (Sabbagh-Ehrlich et al., 2005). There are a number of factors that increase the hours that truck drivers work beyond simply the distance between origin and destination. These include operational factors like the need to wait for loading activities and organisational factors like incentive payments that encourage longer hours of work by paying drivers by the work output (by kilometre or by trip) as distinct from time-based payment where drivers are paid by the hours of work they do.

Waiting for loading activities can prolong work significantly, with potential carryover effects on fatigue and driving. Truck driver surveys in Europe (Hamelin, 1999) showed that truck drivers spent 20–25% of their total work time in loading/unloading activities and up to one third of work time if waiting time was included. Surveys of Australian truck drivers indicated that about 15% of work time was spent in loading related activities (including waiting to load/unload) and increasing time spent loading/unloading was significantly associated with more frequent reporting of fatigue, dangerous on-road experiences and falling asleep while driving (AMR Interactive, 2007). Similarly, in the US, Morrow and Crum (2004) showed that more time spent in loading and unloading activities predicted truck crashes. Furthermore, McCartt et al. (2008) found that US drivers required to wait to pick up or drop off loads were significantly more likely to violate hours of service rules, with increasing likelihood of violating the longer they were required to wait. These results suggest that waiting time arrangements present a problem for long distance truck drivers and increase the likelihood of adverse outcomes like fatigue and crashes.

There is less evidence on the influence of incentive or productivity-based payments on work practices in the long distance road transport industry. In Australia, incentive-based payments are very common in this industry, with at least two-thirds of drivers (including around half of employee drivers), paid on an incentive basis either by the trip or the kilometre (Williamson et al., 1992, 2001; AMR Interactive, 2007). Notably, these surveys also found that incentive payments were associated with longer trips and greater likelihood of experiencing fatigue. A modelling study of truck driver accidents and compliance with working hours regulations found that drivers who were under economic pressure due to incentive payments were more likely to be involved in crashes (Williams and Monaco, 2001). Reducing incentive payments were also highlighted as an issue of concern in other studies although no evidence was presented in either study (Arboleda et al., 2003; Sabbagh-Ehrlich et al., 2005). This study will investigate the relationships between incentive payments, waiting time and fatigue experiences for long distance truck drivers. The objective of this study was to develop a better understanding of the relationships between external non-driving factors, such as waiting time and incentive-based remuneration, and fatigue outcomes for long distance truck drivers in the eastern states of Australia. In this study, fatigue was defined broadly to include: drowsiness and sleepiness as well as feeling tired, lethargic, bored, unable to concentrate or sustain attention and feeling mentally slowed. Based on previous research, drivers paid on trip-based or incentive payments would be more likely to do longer distances and hours of work, so compromising their sleep opportunities and increasing the likelihood of experiencing fatigue. In a similar vein, it would be predicted that factors that require drivers to spend long periods waiting for non-driving activities, such as waiting in queues for loading or unloading will do longer hours of work and will therefore be more likely to experience fatigue. Where waiting time is unremunerated, this effect would be predicted to be greater as drivers need to do more remunerated work to compensate which in turn would increase the likelihood of experiencing fatigue. Overall, it would be predicted that the way drivers are remunerated will influence their motivation to do longer trips, which in turn will influence their experience of fatigue.

2. Method

2.1. Design

A cross-sectional survey design was used to gather information from long distance truck drivers in New South Wales (NSW). Drivers were surveyed about their exposure to external factors that might influence their ability to manage fatigue and safety, including their employment status, fatigue management arrangements, payment system, waiting and queuing time, and working hours. Outcome measures of fatigue experiences were also collected.

Consistent with the NSW Road Transport (General) Regulation 2005, 'long distance' work was defined as extending more than 100 km from the home base or depot. At the time of the survey, standard work hours regulations for truck drivers in NSW allowed up to 12 h work in 24 h, up to 72 h work time in 7 days, and 144 h work time in 14 days. In addition, they were required to have at least 60 min rest time during the 12 h work period broken up into 15 min minimum within 5.5 h into the trip, 30 min within 8 h and 60 min within 11 h, as well as 7 h continuous stationary rest time in 24 h, 24 continuous hours stationary rest time in 7 days and two 7 h night rest breaks plus two consecutive 7 h night rest breaks taken in 14 days. The working hours regulations also incorporated two alternative compliance approaches involving more flexible hours. Basic Fatigue Management (BFM) allowed trucking company operators greater control over work and rest of their drivers, including the possibility of working up to 14 h in 24, provided the risks of working longer shifts and night hours are properly managed. Advanced Fatigue Management (AFM) allowed greater flexibility over work and rest but requires operators to demonstrate greater accountability for managing fatigue risk through taking a risk management approach. Both alternative compliance approaches are only available to operators through an accreditation scheme (see http://www.nhvr.gov.au/safety-accreditation-compliance/fatigue-management for further details).

2.2. Sample

A total of 475 drivers provided usable survey responses from 1597 approached, representing a 30% return rate. Almost all participants were male (98.3%). Approximately two-thirds (67.3%) opted to complete a self-administered form which was returned to the