TØI report 1279/2013

Ross Owen Phillips
Torkel Bjørnskau

Institute of Transport Economics
Norwegian Centre for Transport Research

# Health, safety and bus drivers

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**Summary:**
A literature review shows that work-related health problems are prevalent in bus drivers. To structure investigations into whether this could be problematic for safety behaviour, a model is developed in which work stressors are linked to safety behaviour via a triad of “duty fitness” factors: psychophysiological stress response, sleep quantity/quality and health status. Analysis of survey responses in a sample of bus drivers in Norway with typical health outcomes, gives some support to this so-called Duty Fitness Model. Future research is recommended to perform a more robust test of the model, and act as a basis for longitudinal studies.

**Sammendrag:**
En litteraturstudie viser at mange bussjåfører har helseproblemer pga. arbeidsbelastninger. For å undersøke om slike helseproblemer kan påvirke trafikksikkerheten er det utviklet en modell for sammenhengen mellom arbeidsbelastninger og kjøredyktighet gjennom variablene i) psykososial stress respons, ii) søvn (mengde og kvalitet) og iii) helsetilstand. En spørreundersøkelse til et utvalg av norske bussjåfører gir en viss støtte for denne ”Duty Fitness”-modellen. Det er imidlertid behov mer forskning, og longitudinelle (kohort) studier vil være velegnet for å teste modellen grundigere.

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# Preface

This is a report about the links between works stressors, work-related health outcomes and safety behaviour in bus drivers. It was researched during the autumn of 2012, and written in September 2013. The report would not have been possible without the generous cooperation of the driver union involved. While we cannot name individuals for reasons of confidentiality, this in no way detracts from the gratitude we owe them.

At TØI, Ross Owen Phillips has researched and written the report. Torkel Bjørnskau has given guidance during the project and is manager for the main project on transport risk, of which this project is part. Fridulv Sagberg has been quality manager of the report and Trude Rømming has edited and prepared the report for printing.

The work is funded by the Norwegian Research Council.

Oslo, October 2013
Institute of Transport Economics (TØI)

*Gunnar Lindberg*
Director

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Institute of Transport Economics
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**Summary:**

# Health, safety and bus drivers

*TØI Report 1279/2013*
*Ross Owen Phillips and Torkel Bjørnskau*
*Oslo 2013, 51 pages English language*

*Work-related health problems are more common for bus drivers than for many other occupations, and the stressors responsible may be on the increase. Although health decrements could well be linked to poorer safety performance in bus driving, little has been done to characterize the relationship between work-related health and safety behaviour. A model is therefore presented as an evidence-based framework, describing that work stressors are linked to safety behaviour via a dynamically interacting triad of "duty fitness" factors: psychophysiological stress response, sleep quantity/quality and health status. Analysis of survey responses in a sample of bus drivers with typical health outcomes, gives some support to this so-called Duty Fitness Model. Future research is recommended to perform a more robust test of the model, and act as a basis for potential longitudinal studies.*

This report describes a literature review and survey analysis, carried out to explore links between work stressors, health outcomes and safety behaviours in bus drivers.

## Poor work-related health outcomes for bus drivers

The literature review shows that work-related health complaints and health-related organizational outcomes are more prevalent for bus drivers than most other occupations. Work-related health problems for bus drivers are typically stress-related psychological disorders and associated physical symptoms (especially elevated blood pressure), musculoskeletal problems, cardiovascular disease, stomach and related gastrointestinal problems, and chronic fatigue or burnout. The main causes are psychosocial stressors. In particular, low control is inherent to the bus driver task, where goal achievement (e.g. arriving on time) is threatened by both competing demands and unpredictable events in the road environment. Physical stressors, sleep pressure and work-home conflict also play a major part in health outcomes for the bus driver. Psychosocial, physical and sleep stressors are often present simultaneously, having confounding affects on health outcomes.

Analysis of a new survey, with responses from 1183 bus driver members of a large transport union in Norway, supports these findings, showing that one in three drivers report a work-related health problem. Complaints reported by the sample are also largely in line with those found in the literature. Notably, 81 per cent of health problems reported were musculoskeletal in nature, with or without associated stress problems.

## Work stressors, health complaints and driving hours transgressions more common for shift workers

The bus drivers in our survey sample also resemble literature reports in that work-related health problems were more abundant among those working shifts (36 per cent reported health problems compared with only 26 per cent of those not working shifts).

Work stressors were also more abundant among those drivers working shifts. Specifically:

- Between 52 and 61 per cent of shift workers reported experiencing various time pressures at work, compared with 31 to 39 per cent of those not working shifts.
- 54 per cent reported conflict between work and home compared with 39 per cent of those not working shifts.

The literature review gave reason to believe that negative health outcomes are detrimental to safety performance, not least due to associated health behaviours (e.g. use of medication) or the cognitive decrements associated with many health problems.

Given the greater shares of shift workers in our sample reporting work stressors and poor health outcomes, we wanted to test whether negative safety behaviours were also more abundant among these respondents. We found that of those who experienced pressure from timetables, 23 per cent of shift workers reported breaking driving time regulations, a share which was significantly greater than the corresponding share of those not working shifts (12 per cent). However, there were no corresponding differences for speeding behaviour.

## Split shifts are particularly challenging

Split shifts have been reported to be a particularly challenging type of shift for bus drivers. Accordingly, greater shares of drivers working split shifts in our sample reported undesirable levels of work stressors, sleep pressure and poor health outcomes. The specific differences were as follows:

- 55 per cent of split shift drivers reported having insufficient time to carry out tasks, versus 47 per cent of drivers working other types of shift
- 75 per cent reported pressure from route timetables, versus 65 per cent of drivers working other shifts
- 59 per cent reported problems balancing work and home life, versus 46 per cent of drivers on other shifts.
- 46 per cent reported shift-related sleep problems, versus 38 per cent of drivers on other shifts
- 41 per cent reported work-related health problems versus 28 per cent of drivers on other types of shift

However, there were no significant differences in the shares of those working split versus other shifts reporting undesirable safety behaviours.

## The Duty Fitness Model

To structure further investigations into any common causes of the poor health outcomes and undesirable safety behaviours seen for bus drivers working shifts, we developed a framework based on the literature review.

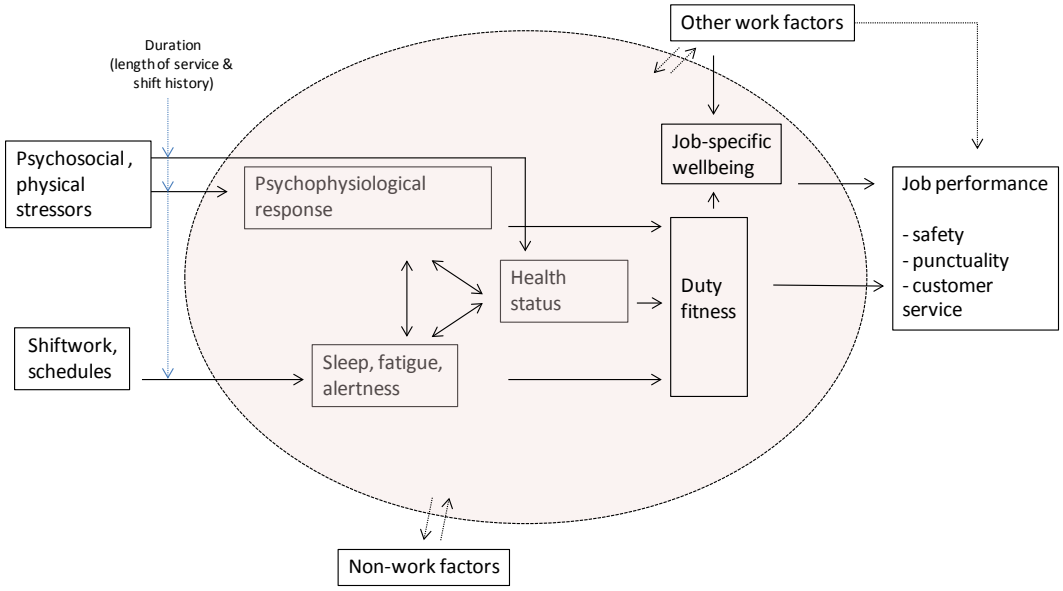



*Figure 1. The Duty Fitness Model. A model of the effect of work stressors on health and safety performance for the bus driver. The pink circle represents the individual. For a detailed description of the model, see main body of report.*

The so-called Duty Fitness Model describes how work stressors (psychosocial stressors, physical stressors, schedules and shift work) together influence a triad of dynamically interacting duty fitness factors – psychophysiological response, health status and sleep – which in turn influence the safety performance of bus drivers.

In support of the model, we found that the share of urban drivers frequently working nights (i.e. high level of both work stressors and sleep pressure from schedules) who reported work-related health problems was almost twice as high as the share reported by rural drivers who rarely or never work nights (low stressors, low sleep pressure).

Analyses of responses from split shift drivers resulted in the following additional evidence in support of the model:

1. Work-related time pressure and work-home balance (work stressors) were each responsible for a significant and substantial variation in the amount of a) shift-related sleep problems and b) work-related health problems.
2. Work-related health problems were linked to shift-related sleep problems.
3. The effects of time pressure at work and work-home balance on work-related health were partially mediated by shift-related sleep problems.
4. For those reporting time pressure due to route timetables, the level of work-home conflict was responsible for a significant variation in reports of the following safety behaviours:
    a. speeding due to time pressure, and
    b. breaking driving time regulations due to time pressure.

5. Addition of work-related health problems as a predictor in the regression model in 4b. resulted in a further small but significant change in the total variance of driving hours transgressions explained.

However, work-related health problems did not result in a significant change in total variance in speeding behaviour explained by work-home conflict.

The limitations of the study include those inherent to *post hoc* analyses, and also that the language of certain of the survey items could be interpreted as leading. Moreover demographics were not assessed in the union survey, and could therefore not be controlled for in the analysis.

## Need for further testing of the Duty Fitness Model

On balance we conclude that the results presented here support further investigation of the need to account for health as a potential factor in safety performance, as a precursor to longitudinal studies into the effects of work stressors on health, sleep, and safety behaviour.

Fatigue, stress and health have mostly been considered as separate factors in relation to both driver health and driver safety, despite the fact that these factors are strongly and dynamically interactive. Likewise, while psychosocial pressures are often cited in relation to health outcomes, sleep undoubtedly plays a role in the effects of these stressors. Our hope is therefore that this is the first of several studies that will contribute towards a more integrated approach to studying health and safety links among bus drivers.

Transportøkonomisk institutt
Stiftelsen Norsk senter for samferdselsforskning

**Sammendrag:**

# Arbeidsbelastinger, helse og sikkerhet blant bussjåfører

*TØI rapport 1279/2013*
*Ross Owen Phillips og Torkel Bjørnskau*
*Oslo 2013 51 sider*

*Arbeidsrelaterte helseproblemer er vanligere blant bussjåfører enn blant andre yrkesutøvere, og problemene kan være i ferd med å øke. Selv om det er gode grunner til å anta at helseproblemer fører til mindre sikker kjøring, er det gjort lite forskning på sammenhengene mellom arbeidsrelatert helse og sikkerhetsrelatert atferd. I rapporten presenteres derfor en modell for hvordan dette kan henge sammen – "Duty Fitness Model". Modellen antar at arbeidsbelastninger henger sammen med sikkerhetsrelatert atferd gjennom tre aspekter ved det å være skikket til å kjøre; psykofysiologisk stress respons, søvn (mengde og kvalitet) og helsetilstand. Analyser av spørreskjemadata fra et utvalg av bussjåfører med typiske helsetilstander gir en viss støtte for modellen. Videre forskning bør gjennomføres for å teste modellen grundigere og for å danne grunnlag for longitudinelle studier der man følger de samme respondentene over tid.*

Den foreliggende rapporten gjengir resultatene fra en litteraturstudie og en analyse av spørreskjemadata som er gjort for å kartlegge sammenhengene mellom arbeidsbelastninger, helsetilstander og sikkerhetsrelatert atferd blant bussjåfører.

## Arbeidsrelaterte helseplager er vanlig blant bussjåfører

Litteraturstudien viser at arbeidsrelaterte helseplager og sykdom er vanligere blant bussjåfører enn blant andre yrkesutøvere. De mest typiske arbeidsrelaterte helseplagene blant bussjåfører er stressrelaterte psykiske plager med tilhørende fysiske symptomer (særlig høyt blodtrykk), muskel- og skjelettlidelser, hjerteproblemer, mage- og tarmlidelser og kronisk tretthet og utbrenthet. De viktigste risikofaktorene som bidrar til helseplager er knyttet til psykososialt stress. Bussjåføryrket kjennetegnes blant annet av liten egenkontroll over arbeidet samtidig som måloppnåelsen (holde ruta) trues både av kryssende hensyn (sikkerhet, komfort) og av uforutsette hendelser i trafikken.

Fysiske stressfaktorer, søvnproblemer og konflikter mellom krav på jobb og hjemme, er også faktorer som påvirker bussjåførenes helse. Dessuten er ofte psykososiale stressfaktorer, søvnproblemer og konflikter mellom krav til jobb og hjem tilstede på samme tid, noe som forsterker de negative effektene på helse.

Det ble gjennomført en spørreundersøkelse blant bussjåfører organisert i Yrkestrafikkforbundet og i alt 1183 bussjåfører svarte. Resultatene viser at én av tre oppgir å ha et helseproblem knyttet til jobben. Helseplagene som ble rapportert var i stor grad de samme som man finner i forskningslitteraturen. Det er verdt å merke seg at hele 81 prosent oppga muskel- og skjelettlidelser enten med eller uten tilhørende stressproblemer.

## Arbeidsbelastninger, helseplager og brudd på kjøre- og hviletidsregler er vanligst for de som kjører skift

Bussjåførene i vårt utvalg var også representative for hva man har funnet andre steder når det gjaldt helseplager knyttet til skiftarbeid. Mange flere blant de som jobbet skift oppga at de hadde helseplager knyttet til jobben (36 prosent) enn blant de som ikke jobbet skift (26 prosent).

Arbeidsbelastninger var også vanligere blant de som jobbet skift:

- Mellom 52 og 61 prosent av de som jobbet skift oppga tidspress på jobb. Tilsvarende andeler blant sjåfører som ikke jobbet skift var 31-39 prosent.
- Blant de som jobbet skift oppga 54 prosent at de opplevde konflikt mellom krav til jobb og krav til hjem. Tilsvarende andel blant de som ikke jobbet skift var 39 prosent.

Litteraturgjennomgangen tydet på at helseproblemer kan ha negative konsekvenser for sikkerheten, både på grunn av medisinering og fordi helseproblemer kan føre til mindre oppmerksomhet i trafikken. Siden sjåfører som jobbet skift oppga flere arbeidsbelastninger og helseproblemer, ønsket vi å undersøke om også sikkerhetskritisk atferd i trafikken var vanligere blant sjåfører som kjører skift. Vi fant at blant sjåfører som kjørte skift og som opplevde tidspress pga. rutetabellen var det 23 prosent som hadde brutt kjøre- og hviletidsreglene. Dette var signifikant flere enn blant sjåførene som ikke kjørte skift, men som også opplevde tilsvarende tidspress (12 prosent). Vi fant imidlertid ikke slike forskjeller når det gjaldt å bryte fartsgrensene.

## Delte skift er særlig utfordrende

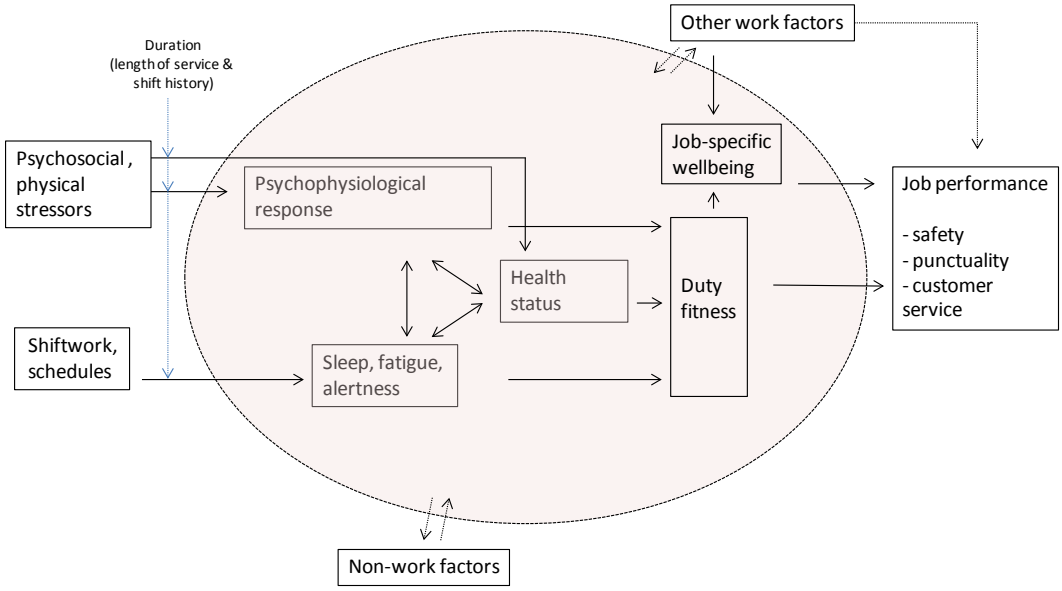
Delte skift er et velkjent problem for bussjåfører. Vi fant at sjåfører som jobbet delte skift i større grad enn andre rapporterte om arbeidsbelastninger, søvnproblemer og helseproblemer. På følgende problemområder var det særlig tydelige forskjeller:

- 55 prosent av de som jobbet delte skift oppga å ha for liten tid til å gjennomføre arbeidsoppgavene, mot 47 prosent av sjåfører som hadde andre typer skift.
- 75 prosent av de som jobbet delte skift oppga tidspress pga. rutetabellen, mot 65 prosent av sjåførene som hadde andre typer skift.
- 59 prosent av de som jobbet delte skift hadde problemer med å forene krav til hjem og jobb, mot 46 prosent av de som hadde andre typer skift.
- 46 prosent av de som jobbet delte skift hadde søvnproblemer knyttet til skiftarbeidet, mot 38 prosent av de som hadde andre typer skift.
- 41 prosent av de som jobbet delte skift oppga at de hadde arbeidsrelaterte helseproblemer mot 28 prosent blant de som hadde andre typer skift.

Det var imidlertid ingen signifikante forskjeller mellom de som jobbet delte skift og andre typer skift når det gjaldt farlig atferd i trafikken.

## "Duty Fitness"- modellen

For å strukturere kartleggingen av årsaker til dårlig helse og trafikkfarlig kjøring blant sjåfører som jobbet skift har vi utviklet en modell for hvordan ulike relevante forhold kan henge sammen, basert på resultatene fra litteraturstudien, se Figur 1.




*Figur 1. The Duty Fitness Model. En modell av effektene av arbeidsbelastninger på helse og sikkerhet blant bussjåfører.*

"Duty fitness" kan oversettes til "skikket til tjeneste" eller "skikket til jobb". Den såkalte "Duty Fitness"-modellen beskriver hvordan arbeidsbelastninger ("psychosocial stressors" (psykososiale belastninger), "physical stressors"(fysiske belastninger), "schedules" (rutetabell/tidsfrister) og "shift work" (skiftarbeid)) påvirker tre dynamisk interaktive "duty fitness"-faktorer: "psychophysiological response" (psykososial respons), "health status" (helse) og "sleep, fatigue, alertness" (søvn, tretthet, oppmerksomhet)) – som igjen påvirker sjåførenes "duty fitness" (skikket til å kjøre). Det antas videre i modellen at "duty fitness" påvirker "job-specific wellbeing" (trivsel/behag på jobb), og at både "duty fitness" og "job-specific wellbeing" påvirker atferd mht. sikkerhet, punktlighet og service.

Vi fant støtte for modellen i og med at andelen blant bybussjåfører som ofte hadde nattskift (og dermed belastninger knyttet til både søvn og tidspress pga. rute/tidsfrist), rapporterte om arbeidsrelaterte helseproblemer dobbelt så ofte som sjåfører som ikke kjørte i bytrafikk og som sjelden eller aldri jobbet nattskift.

Analyser av svarene til sjåførene som jobbet delte skift, ga i tillegg støtte til modellen på følgende punkter:

1. Arbeidsrelatert tidspress og motstridende krav til hjem og jobb hadde begge sterke og statistisk pålitelige effekter på graden av a) skiftrelaterte søvnproblemer og b) arbeidsrelaterte helseproblemer.
2. Arbeidsrelaterte helseproblemer hang sammen med skiftrelaterte søvnproblemer.

3. Tidspress på jobb og motstridende krav til hjem og jobb hadde effekter på arbeidsrelaterte helseproblemer, men disse effektene ble modifisert av skiftrelaterte søvnproblemer.
4. Blant de som rapporterte om tidspress pga. rutetabellen, påvirket motstridende krav til jobb og hjem hvordan man kjørte:
    a. de hadde signifikant mer kjøring over fartsgrensen pga. tidspress og
    b. de hadde mer brudd på kjøre- og hviletid pga tidspress.
5. Da vi inkluderte arbeidsrelaterte helseproblemer i en regresjonsmodell for å forklare brudd på kjøre- og hviletid (4b) fant vi at dette hadde en liten, men signifikant effekt på omfanget av brudd på kjøre- og hviletid.

Vi fant imidlertid ikke at arbeidsrelaterte helseproblemer påvirket effekten av motstridende krav hjem/jobb på omfanget av kjøring over fartsgrensen (4a).

Det er visse begrensninger i studien som gjør at vi bør være noe varsomme i tolkningene. For det første er studien *post hoc*, dvs. at vi leter etter sammenhenger i et datasett uten at spørsmålene er skreddersydd på grunnlag av på forhånd oppsatte hypoteser. For det andre kan det innvendes at spørsmålene til en viss grad framstår som ledende. Og endelig har vi ikke data for alder på respondentene, noe som kan påvirke både hva slags skiftordninger de har og helseproblemer mv. Ideelt sett burde vi ha kontrollert for alder i en slik analyse.

## Behov for ytterligere testing av Duty Fitness-modellen

Alt i alt vil vi konkludere med at resultatene som er presentert her, viser at det er behov for ytterligere kartlegginger av forholdet mellom helse og sikkerhet i trafikken. Vi ser særlig behovet for såkalte longitudinelle studier eller kohortstudier der vi undersøker sammenhengene mellom arbeidsbelastninger og helse, søvn og kjøreatferd over tid blant de samme sjåførene.

Tretthet, stress og helse er vanligvis vurdert som separate faktorer som påvirker føreres helse og atferd i trafikk, til tross for at det er sterke og dynamiske sammenhenger mellom disse faktorene. Det er kjent at psykososiale faktorer er viktige for helse, men hvordan forhold knyttet til søvn påvirker slike sammenhenger er mindre kjent. Vårt håp er derfor at dette er en første av flere studier av slike forhold og at den vil bli fulgt opp av mer dyptpløyende undersøkelser av sammenhengene mellom helse og sikkerhet blant bussjåfører.

# 1 Background

Through a project on driver fatigue in Norway, we became aware of the availability of data from a large survey carried out by a professional driver union in Norway.

The survey contained items covering aspects of driver health, fatigue and safety behaviours, thus allowing the potential exploration of links between safety behaviour and long-term work-related health outcomes in professional drivers. We believed that these links, while potentially important, had not been sufficiently accounted for in the research literature.

Upon enquiry, the driver union was willing to let us analyse the data in exchange for a report on responses from bus drivers working split shifts.

While this current report also presents our findings on the work situation for split shift drivers, its main focus on the links between works stressors, work-related health outcomes and safety behaviour in bus drivers.

The work is funded by the Norwegian Research Council.

# 2 Aims

The aims of the report are as follows:

- Review evidence on the relationships between work stressors, health outcomes and the safety behaviour of bus drivers.
- Assess by *post hoc* survey analysis the prevalence and nature of work stressors, health outcomes and safety behaviours for bus drivers in varying job situations, including and especially those working split shifts.
- Present an evidence-based model of the effects of work stressors on health and safety outcomes in bus drivers.
- Conduct preliminary tests on aspects of the model by *post hoc* regression analyses of survey responses from bus drivers working split shifts. More specifically, the analyses set out to determine the extent to which:

    1) work-related health problems are linked to the work stressors time pressure at work and work-home balance;
    2) any links between work stressors and health complaints are mediated by shift-related sleep problems; and
    3) general safety behaviours can be explained by work-related health outcomes and shift-related sleep problems.

# 3 Introduction

Between 2005 and 2008 there were between 800 and 1200 fatalities across 19 EU countries every year associated with buses or coaches (DaCoTa, 2010). Of these fatalities 13 per cent were to the occupants of the buses. Thus although bus travel is not seen as a high risk transport relative to the car or other personal transport forms, there is still need to reduce the number of deaths and injuries resulting from crashes in which buses are involved.

The occurrence and severity of accidents involving buses will in part be determined by the safety behaviour of the bus driver, which encompasses the driving task and other tasks such as pre- and post-trip checks or passenger supervision (Broughton, Baughan, Pearce, Smith & Buckle, 2003).

In the case of Norway at least, there is reason to believe that the safety behaviour of bus drivers can be improved. Over half of the drivers in a recent survey of bus companies here reported being involved in at least one accident or a near miss during the last three years (Moe, 2006). Poor maintenance, lack of attention, poor decision making, fatigue and distractions were abundant causal factors. Moreover, half of the drivers reported consciously and consistently exceeding the speed limit.

There are many influences on safety behaviour. They can classified as those at the level of the individual driver (e.g. sleep history, driving experience or age), the vehicle and traffic environment (e.g. passenger distractions, poor road visibility), the employing organization (e.g. safety climate and culture), or the transport sector (e.g. emphasis on competition, value of safety vs. punctuality) (Bjørnskau & Longva, 2009; Elvik, Høye, Vaa & Sørensen, 2009; Evans & Johansson, 1998; Williamson et al., 2011).

One important way in which bus companies can improve safety behaviour is by accounting for the ways in which organizational-level work stressors affect safety performance when designing jobs and schedules. An obvious example is to ensure that drivers have sufficient time to reach bus stops punctually even in congested traffic, such that they do not feel compelled to drive unsafely due to time pressure (Meijman & Kompier, 1998). Another is to ensure that schedules give sufficient opportunity for sleep, such that the drivers are not fatigued while driving (Phillips & Sagberg, 2010).

The main concern of this report is whether companies should also be considering the more indirect effects that time pressure, poor sleep and other work stressors might have on bus driver safety performance, namely via the chronic health decrements with which they are often associated (Cunradi, Greiner, Ragland & Fisher, 2003; Duffy & McGoldrick, 1990; Greiner, Krause, Ragland & Fisher, 1998).

Bus operations face pressure from an increasingly congested society placing greater demand for competitive and efficient service at all times of day (Longva, 2008). For many drivers this means increased time pressure while driving and the need to work shifts, the latter putting increased strain on home life and increasing fatigue (Evans, 1994; Folkard, 1997; Hughes & Bozionelos, 2007). At the same there are signs that

the social support available to bus drivers is decreasing, with increased reliance on technology and internationalization of the work force. The detrimental effects of high demands and low social support on employee strain, sleep and ultimately health may thus be increasing, and growing in complexity. Yet we do not really know to what extent work-related health decrements have knock-on effects for safety performance.

Are there changes in the safety performance of bus drivers that are specifically caused by work-related health decrements? And if there are, can companies address the problem by redesigning jobs? Answering these questions requires improved understanding of the links between work stressors, health outcomes and job performance. Specifically, there is a need to know whether work stressors affect safety performance of the bus driver via their longer term effects on driver health. Such links, if established, would give organizations even more reason to design jobs that are optimal for employee wellbeing.

Here we present a preliminary exploration of the effect of work stressors on the health status and safety behaviour of bus drivers, with an emphasis on the links between work-related health status on the one hand and safety performance on the other. The report is in three parts: a literature review (section 4), a survey analysis (section 5), and summary and conclusions (section 6).

In the literature review we summarise the international literature on work-related health and sleep outcomes for bus drivers. The literature often describes poor health outcomes for bus drivers, and although time pressure and other job demands are frequently given as a main cause, we find that the extent to which this is true for different types of driving situation is not clear. In addition to psychosocial stressors, physical stressors and demanding work schedules are reviewed as causes of poor health outcomes in bus drivers. The interactive role that poor sleep and poor health play in the effects of work stressors is complex, and we argue that the implications for bus driver safety behaviour go beyond the direct effects of fatigue and sleepiness on driving behaviour.

Ultimately the review pays attention to the impact that health outcomes might have on safety performance. A new model is presented that outlines how work stressors could lead to decrements in driver safety performance via their effects on health. This model is termed the Duty Fitness Model.

The next section of the report (section 5) describes the *post hoc* analysis of a union survey to explore links between work stressors, health outcomes and safety behaviours among a sample of Norwegian bus drivers. The analysis is structured by the Duty Fitness Model.

To begin with we analyse the prevalence and nature of health outcomes for our sample of bus drivers. Then we test for links between different bus driver contexts (implying varying levels of demands) and the health outcomes reported, in part to help clarify whether different demands in different job situations have varying effects on health. We next focus the analysis on drivers working demanding split shifts, thus controlling for differences in shift types. We ask to what extent the health outcomes reported by these drivers vary with reports of the work stressors "time pressure on the job" and "work-home conflict", and whether any relationship between these work stressors and health is mediated by sleep quality. Ultimately we test whether any variation in reported safety behaviours is explained by work-related sleep and health problems; and in the most rigorous test of the Duty Fitness Model, we analyse

whether any links between work stressors and safety behaviours are mediated by work-related sleep or health outcomes.

In the final section (section 6), the findings of section 5 are summarized, and recommendations made for future work.

# 4 Literature review: Work-related health status and safety behaviour of bus drivers

International research has characterized the nature and causes of work-related health outcomes for bus drivers. A variety of health complaints are found, often due to long-term challenge from psychosocial and / or physical stressors in the work environment. These stressors are described after a short consideration of the types and prevalence of health complaints reported by bus drivers and others in a similar role. Finally we consider some of the consequences of poor health outcomes for bus drivers.

## 4.1 Nature and prevalence of work-related health outcomes

In the mid-1970s a study of 15,000 employees working in Oslo in various occupations found that bus drivers had the worst health, based on cholesterol levels, blood pressure and weight (Holme, Helgeland, Hjermann, Leren & Lund-Larsen, 1977). Other countries and more recent studies continue to find that health outcomes, including disability, turnover and sickness absence, are poorer for bus drivers than they are for most other occupational groups (Benavides, J., Mira, Sáez & Barceló, 2003; Kompier, 1996b; Kompier & Di Martino, 1995; STAMI, 2011; Winkleby, Ragland, Fisher & Syme, 1988).

Several studies also report high levels of health-related attrition from the job for bus drivers beginning at an early age, with reviews highlighting cardiovascular disease, musculoskeletal complaints, psychosomatic disorders, stomach disorders, chronic fatigue and burnout as the most common reasons for leaving (Evans, 1994; Kompier, 1996b; Netterstrom & Laursen, 1981; Tse, Flin & Mearns, 2006)

Musculoskeletal disorders in particular are a major problem for bus drivers (Tse et al., 2006). Frequently reported complaints for Norwegian drivers resemble those reported by drivers from other countries, and involve pain radiating from the lower part of the back, neck, shoulders, the upper part of the back and the knees (Moe, 2006).

Psychological complaints also prevail at particularly high levels. These are closely associated with fatigue, stress (high blood pressure and cortisol levels have been measured in several urban driver populations), depression, anxiety (Tse et al., 2006), and stomach complaints, which are all frequently reported by drivers (Anderson, 1992).

Several common psychological complaints and associated symptoms have been positively associated with service length (Issever, Onen, Sabuncu & Altunkaynak, 2002).

Work on stress in bus drivers often cites health consequences at the individual level as varied, including physiological aspects (tiredness, frequent infection, health complaints, signs of depression, weight change), emotional aspects (apathy, cynicism, sad, anxious) and behavioural aspects (absenteeism, accidents, increase in alcohol/caffeine use, obsessive exercising, irrational behaviour, reduced productivity) (Kompier & Di Martino, 1995).

In some reports fatigue and burnout are also addressed as health outcomes, but they are considered by others as factors mediating the effects of poor sleep on other health outcomes, as well as job performance outcomes (e.g. reduction in ability to monitor critical signals in safety performance).

## 4.2 Job stressors contributing to poor health outcomes

Even in physically demanding jobs, psychosocial factors can be the main cause of poor health outcomes (Aptel & Cnockaert, 2002). The need to understand the role of psychophysiological response in health outcomes in bus drivers, for whom the main challenge is psychosocial demands, is therefore paramount.

### 4.2.1 Psychosocial factors

The main psychosocial factors that can be considered to contribute to health problems for bus drivers are varying and conflicting demands, and poor job resources with which to deal with those demands. Other psychosocial factors, such as stress from the threat of verbal or physical abuse are also found, and may be on the increase. Each of these factors is now discussed below.

#### 4.2.1.1 Varying demands

A high strain work environment is one characterized by high demands coupled with low control and little social support at work (Karasek & Theorell, 1990). It can lead to severe health problems, including coronary heart disease. Current evidence supports that job demands and resources (which include job support and job control) remain among the most important factors in work-related psychosocial health (Fernet, Austin & Vallerand, 2012; Halbesleben & Buckley, 2004).

The question then is which psychosocial demands do bus drivers face and what job resources do they have to help them?

A comprehensive review of research on stress in bus drivers finds consensus that the role is a classic high strain occupation, in which high demand situations arise from the need for continuous vigilance, monitoring and multitasking in complex traffic situations in which mistakes can have serious consequences (Kompier & Di Martino, 1995; Moe, 2006; Normark & Juhlin, 2000). Recent years have seen an increase in these problems, with increased congestion and even less room for error in route timetables (Bråten, Hovi, Jensen, Leiren & Skollerud, 2013).

Between 30 and 40 years ago studies in European countries began to link these high demands to relatively poor health outcomes for bus drivers in terms of work disability, sickness absence and turnover (Aronsson, 1982; Erlam, 1982; Netterstrom & Laursen, 1981). Urban bus drivers in the USA have also been found to be subject to extreme time pressures, leading to sustained hypertension and sickness absence (Greiner, Krause et al. 1998).

Some researchers claim that demands placed on operators have only grown as a result of deregulation and increased fluidity in the commercial transport sector (Nielsen, Nielsen et al. 2010). Indeed one attempt to implement technology to assist in timetable coordination tasks only served to increase time pressures and complexity of the work environment still further (Normark & Juhlin, 2000).

Despite international evidence for high job demands in bus drivers, the evidence in Norway is more mixed. While the 2011 Norwegian work environment monitoring survey (*NOA*) report finds that both transport operators and drivers/crew working in road haulage, construction and shipping, have above average job uncertainty, the demands experienced by transport workers are reportedly among the lowest of any profession (STAMI 2011). On the other hand studies focused on bus drivers find that for many drivers in Norway, demands are actually very high (Longva, Osland et al. 2007; Enehaug and Gamperiene 2010).

The disparate findings of broad and focused surveys may indicate a need to account for the widely different contexts in which different bus drivers operate. Support for this comes from studies on urban and rural truck drivers, reporting in detail the varying demands faced daily by urban drivers, with clear relations between demands and the extent of mental health problems (Enehaug and Gamperiene 2010). In contrast, the challenge for the rural driver is stress from cognitive underload combined with poor sleep, and the pathways to poor health and preventative measures may be different (Friswell & Williamson, 2013).

With this in mind it is interesting to ask whether demands placed on bus drivers in Norway vary according to job situation. One would not for instance expect a driver operating a quiet daytime rural route in northern Norway, which has a relatively sparse population, to experience the same level of demands as one who works shifts in rush hour traffic in Oslo.

Whatever the case, it should be noted that while nearly all studies of bus driver stress agree that the job is one with high demands, most do focus on urban bus drivers (Kompier, 1996b; Kompier & Di Martino, 1995). In assessing psychosocial demand levels, the specific job situation of the bus drivers in questions do therefore need to be considered.

#### 4.2.1.2 Conflicting demands

The way different job demands often conflict (role conflict) has been documented for Swedish bus drivers by Gardell, Aronsson and Barklof (1982). The employer requests that the driver (i) maintain a positive service-orientation, while at the same time (ii) keeping to the timetable and (iii) driving safely. These demands present a three-way role conflict to all bus drivers. One way in which drivers can deal with this is to treat passengers as cargo, and focus on punctuality and driving safely, an approach that is known to reduce job satisfaction. The other is to handle passengers in a personal way while trying to make up for time lost by speeding. Whichever choice is made, the driver "will constantly have a conscious or subconscious feeling of inadequacy", because he or she can never fulfill the conflicting demands placed on them.

#### 4.2.1.3 Low job resource

Job resource comprises job control and job support, the latter encompassing social support from peers and colleagues, as well as job-related information and feedback.

Job control (decision latitude) comprises the variety of tasks one can perform on the job, and the freedom or autonomy one has to select those tasks (Karasek & Theorell, 1990). A meta-analysis confirms that low job control is a predictor of poor health outcomes (Duijts, Kant, Swaen, van den Brandt & Zeegers, 2007). This is of concern because there is little doubt that bus drivers, like many other transport operators, have both low task variety and little autonomy, and therefore low job control. Even at the extent to which it is possible, control in the form of participative decision making (e.g. route planning, choice of equipment) is low (Nehls 2003; Enehaug and Gamperiene 2010). Unsurprisingly, clear links have been demonstrated between level of control and musculoskeletal complaints in bus drivers (Kompier & Di Martino, 1995)

There is also some evidence that frustrations from lack of control are exacerbated by lack of job support, in terms of both information and feedback, and the social support available to them. For instance, bus drivers complain of a lack of performance feedback from the work environment and lack of recognition from managers (Kompier, 1996b). In Norway the share of transport workers reporting that they lack information that they need to do their job is higher than it is for most other occupations, and bus and train drivers are highlighted for low levels of performance-related support and feedback, especially from leaders (STAMI 2011).

Lack of social support for bus drivers is to some extent an inherent part of their distributed work situation. Norwegian drivers report high levels of trust among colleagues that are undermined by social interactions which are severely restricted by the severe time pressure, high demands and organizational politics of a highly competitive bus sector (Moe, 2006). Similar problems have been reported for bus drivers in the UK (Duffy & McGoldrick, 1990).

Lack of support from colleagues is confounded by the difficulties supervisors have in gaining insight into the challenges faced by workers on the road. The potential for improving low levels of social support experienced by drivers is illustrated by a trial in which teams introduced in selected Norwegian bus companies with self-elected leaders coincided with greater job satisfaction and a drop in sickness absence (Longva, Osland et al. 2007).

For many bus drivers, then, low control, lack of feedback and low levels of support have been found. Where job demands are high, such a scarcity of job resources with which to deal with them will often lead to strain and poor health.

#### 4.2.1.4 Other psychosocial factors

In addition to those factors listed above, one Dutch study finds that a substantial share of bus drivers complain of work-home conflicts (35 per cent) and anxiety due to fear of assault (30 per cent), both factors which have become more frequent in recent times (Kompier, 1996b; Tse et al., 2006). In the USA the problem is now so abundant that a national report has recently been published on preventative measures (TCRP, 2011).

Between ten and 15 per cent of bus drivers in Norway have experienced bullying or assault, a factor associated with longer periods of sickness absence (Moe, 2006). A recent survey found that bus drivers were more insecure than taxi, lorry, train or tube drivers, and that insecurity increased with age and experience (Fyhri & Nævestad, 2011).

One UK study reports the share of bus drivers regarding different stressors as regular or major problems as follows (Duffy & McGoldrick, 1990):

- Worries about theft or assault (67-70 per cent)
- Worries about running times and delays (55-69 per cent)
- Lack of influence on own job (59 per cent)
- Lack of job recognition (53 per cent)
- Health/sleep problems (21-34 per cent)
- Work-home conflict (25 per cent)

The bus drivers were found to demonstrate lower levels of job satisfaction and unfavourable scores on mental-health indices when compared to normative samples. These differences were both found to be linked to work-related stressors.

Finally we might also consider poor sleep as a work-related psychosocial stressor, given that it is often imposed by antisocial shift schedules or sleep at unusual times of the day. Sleep is considered in a separate section below.

### 4.2.2 Physical stressors

There are challenges for bus drivers from the environment surrounding the bus, and the sitting/steering position within the bus. Although there have been ergonomic improvements made to the layout and seating in the cabin, the seating position remains forced and unchanging, which can lead to spine twisting and a fixed posture which leads to the holding of tense areas of musculature over sustained periods, leading over time to chronic wear of tissue, bone and joints. Moreover, maintenance of a forced sitting position curves the spine, relaxes the gastrointestinal muscles and enforces shallow breathing, and over time is thought to lead to stomach problems (Tse et al., 2006).

Road and engine vibration is also reported as a factor that can lead to musculoskeletal complaints, although improved seat and engine design may have reduced the importance of this factor relative to others. Indeed, psychosocial factors alone have been shown to result in spinal injury in bus drivers, after physical load is accounted for (Krause, Ragland, Greiner, Syme & Fisher, 1997).

According to a recent report published in Norway, speed humps are also seen by drivers as a problem linked to stress and back pain (Bråten et al., 2013).

Several hours can often pass before the driver gets a chance for a formal toilet break, especially during rush hour driving. Indeed this is a factor that may be neglected in terms of the physical stress caused to the driver, with driver schedules in Norway, for example, in some cases making toilet breaks difficult before several hours have passed (personal communication, union representative).

Weather conditions, particularly in the winter, can increase the level of demands placed on drivers, by increasing delays and the need to focus on safety. For drivers in more populated areas there is continual change in temperature and humidity due to frequent stopping and opening of doors. Blinding glare from the sun or other vehicles is also a problem.

Within the bus there can be poor illumination within the cabin. This can lead to musculoskeletal problems or confound those caused by psychosocial factors.

When considering the health of bus drivers it will also be important to consider that musculoskeletal disorders due to forced driving position and psychological

complaints are mutually influential through psychosomatic processes, even though these processes are relatively poorly understood (Bongers, de Winter, Kompier & Hildebrandt, 1993)

### 4.2.3 Work schedules

A driver is said to work shifts when he or she does not always work at the same time of day.

Research on shift workers shows that the design of the shift system (e.g. rest time between shifts, and speed and direction of rotation) has an impact on sleep quality, sleep duration, the time of day of sleep, and regularity of sleep. It is therefore a key factor in determining levels of work-related fatigue (Sallinen & Kecklund, 2010).

Despite recommendations that fixed work schedules should be used that would lessen fatigue and establish regular mealtimes, many bus drivers continue to work complicated and unpredictable shift patterns, designed to cope with a demand for bus transport which varies over the course of a day and week (Longva and Ruud 2003). In fact, of all occupations in Norway, it is known that transport operators are second only to nursing and care workers in the extent to which they work shifts (STAMI 2011). The shifts that they work are often rotating, night or split shifts.

The key aspects to consider regarding the ways in which the schedule affects sleep quality of bus drivers have been classified as follows (Kompier, 1996b):

*Total working hours (per week):* Not normally of concern, it is more often how the hours worked are arranged over the course of a working week that is a challenge for bus driver sleep.

*Breaks (during a working day):* For bus drivers these can be too few and too short in duration, or begin too late in the day. Where these breaks are taken is important, in terms of the availability of refreshment, toilet and rest facilities.

*Predictability of assignments:* At one extreme bus drivers can drive the same route every day for six months or more. At the other extreme, there are stand-in drivers who do not know where and when they will be working the next day, or from day to day. The latter are subject to high levels of uncertainty, which would be expected to increase stress (Beehr, 2000).

*Shift type (split or continuous):* Shifts can either be continuous, in which hours are worked continuously in a single spell, or split in which a morning and afternoon or evening shift are worked with a long break in between. Continuous shifts can be early (e.g. 06:00 – 14:00 h), daytime (e.g. 08:00-16:00 h) or late (e.g. 14:00-22:00 h). In cities and on long-distance, express or airport bus routes there can also be night shifts. Continuous shifts are typically arranged such that drivers work two (early and late) or three (early, daytime and late) types of shift, working one type of shift one week, and swapping to another type of shift the next week. Some companies running urban services use split shifts to cover demand during morning and afternoon rush hour, as people head to and from work. The times vary, but a driver may begin at 06:00 h and continue to 10:00 h; they can then be free until, say, 15:00 h when they work until 19:00 h. Thus the working day effectively spans 12 or 13 hours, especially for those drivers who find it difficult to relax or who cannot travel home during the midday break. According to Kompier (1996) split shifts are "a very unfavourable variety of shift work" as regards health and wellbeing.

*Forward / backward shift rotation:* It is much easier for drivers to adapt to changes from an early shift one week to a late shift the next week (with say a day in between) than the other way round. Thus forward rotation of the shift in time is better than backward rotation in terms of health outcomes.

Examples of different shift types for bus drivers in Norway, including split shifts, are given in Appendix 1.

Insufficient sleep arising as a result of long-term shift work may be an important factor in the poorer health outcomes also associated with shift workers e.g. (Phillips & Sagberg, 2010; Wagstaff & Lie, 2011). Sleeping disorders are characteristic for bus drivers, and are especially related to the early shifts (Kompier, 1996b).

In addition to the sleep problems caused by working shifts, the social problems resulting from lack of interaction with those working regular hours are well documented for bus drivers, and there can be reduced parent-child contact or problems unwinding at home, which also lead to stress-related health problems over time (Tse et al., 2006).

Finally, questionnaire-based, prospective, studies show that job stress predicts poor sleep and fatigue (de Lange, Kompier et al. 2009). Thus the health effects of work schedules may be exacerbated by work-related stressors such as time pressure, high work demands and insufficient rest breaks, in addition to those life stressors outside work. Worse still the personal health behaviours (nutrition, exercise) thought to counter stress effects on sleep, are particularly poor for occupational drivers who work shifts (Hedberg, Jacobsson et al. 1993).

As far as we know there has been little exploration of the role of fatigue in exacerbating the psychophysiological effects of stress or poor health in transport workers, but psychological problems *have* been reported as the cause *and* consequence of sleeping problems in bus drivers (Kompier, 1996b). For long-term duty fitness it is undoubtedly the interaction between fatigue and stress that is important. Those drivers who are continuously stressed by the job and experience sleep pressure from work schedules over a prolonged period will eventually enter a vicious circle, where psychological problems caused by the interaction of (i) stress on the job and (ii) fatigue from schedule-restricted sleep will only serve to exacerbate sleep difficulties, reducing further ability to cope with stress, and so on. A key question is what effects such a synergistic interaction will have on safety performance in the long term.

## 4.3 Consequences of work-related health decrements (other than for safety performance)

In the previous sections we reviewed how a combination of increased job demands, lack of resource, physical stressors and challenging work schedules can lead to serious health implications for bus drivers. This pattern is supported by general reports on the links between health and working conditions for bus drivers (EU-OSHA, 2011; Schjøtt, 2002).

For drivers with more serious health outcomes there are obvious personal consequences, including severely reduced quality of life or inability to work, and reliance on medication. Unfortunately, these outcomes may often lead to further problems, such as anxiety or depression, or poor or increasingly worsening sleep. These consequences are often also causes of poor health, which means that a vicious

circle is entered in which health outcomes lead to poor sleep or psychological problems that exacerbate the symptoms of the original outcome, or lead to further or more complicated health outcomes.

Thus the dynamic interaction and duration of psychophysiological stress response, and sleep deficiency, and previous health problems must be considered together when determining the health status or duty fitness of bus drivers.

## 4.4 Links between work-related health outcomes and safety performance

For health conditions that have obvious implications for safe driving, due to the risk of sudden incapacitation of the driver, the links between health and safety are well known. These include sudden cardio- and cerebrovascular episodes (Hitosugi M, 2012), neurological fits (Parsons, 1986), narcolepsy (Kotterba et al., 2004), or hypoglycaemic episodes from type I or II diabetes (Stork, van Haeften & Veneman, 2006).

While sudden health episodes are important for the bus driver safety, we do not consider them in depth here because there is often little the company can do *in terms of job redesign* to prevent them[1].

Moreover, we have seen that the most abundant negative health outcomes for bus drivers are stress disorders, musculoskeletal complaints, stomach complaints, cardiovascular disease and chronic fatigue or burnout. These conditions are often indicative of general depreciations in health status, which we believe may affect driver safety performance in more subtle and persistent ways that may be difficult for organizations to detect.

First, most if not all of these conditions may also lead to the use of medication that can lead to safety decrements, at least while driving (Li, Brady & Chen, 2013).

Moreover, any condition which affects driver's cognitive faculties is likely to lead to reduced safety performance, because safe driving demands sustained attention and vigilance in addition to rapid decision making and response behaviours. There is growing evidence that the two main psychological disorders, depression and anxiety, are often associated with cognitive dysfunction (Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari & Lönnqvist, 2008). Indeed there is some specific evidence of cognitive interference from chronic stress and anxiety in driving tasks, through mechanisms such as attentional overload and slower identification of peripheral lights (Taylor & Dorn, 2005). The abundance of stress-related disorders as a common health outcome for bus drivers is therefore very concerning in terms of their safety behaviours.

Cardiovascular disease is known to be associated with slower reaction times, but again we know little about the implications for safe driving as the disease progresses (Jovanovic, Batanjac & Jovanovic, 1999).

Cognitive decrements associated with health problems will of course be exacerbated if the driver in question is also tired from overwork, working shifts or challenging schedules (Phillips & Sagberg, 2010).

[1] Such episodes are best prevented through health screening both during recruitment and afterwards.

There are also other ways in which health decrements might contribute to poorer safety performance. Depreciations in health in the form of fatigue or chronic pain from musculoskeletal disorders may lead to coping responses such as reduced self-regulation (L. Barber & Munz, 2010), or in the longer term burnout (Maslach, 2000; van Dam, Keijsers, Eling & Becker, 2011). Both self-regulation and burnout have implications for safety, as we now briefly consider.

Repeated bouts of insufficient sleep over the course of days or weeks lead to psychological strain, which comprises two main aspects: mental fatigue and reduced capacity for self-regulation (L. K. Barber, Munz, Bagsby & Powell, 2010). When one has not slept enough difficult or effortful tasks lead to mental fatigue, whereas draining tasks requiring self-control (e.g. decision making, impression management, resisting temptations, risk taking) lead to lowered self-regulatory capacity. There are clear implications of the latter for safety behaviour in bus drivers. A driver with reduced self-regulation due to health problems causing fatigue may for instance be less inclined to bother with a safety check, or may more easily turn to tobacco or medicaments to handle stress (Tse et al., 2006). (See Appendix 2 for further discussion of self-regulation.)

In the case of burnout resulting from high demands coupled with other psychosocial pressures, there is likely to be an influence on safety performance through disengagement from the job, an effect that will be confounded by driving errors (more slips and mistakes, reduction in vigilance) induced by driver fatigue (Brown, 1994; Amundsen & Sagberg, 2003; Mackie & Miller, 1978; Mohamed et al., 2012; Phillips & Sagberg, 2013). (See Appendix 2 for further discussion of burnout.)

The effects of health outcomes on other behaviours may also have implications for safety behaviour. One example is the link between stress and the increased food intake, which over the long term may lead to obesity and restrict physical flexibility (Evans, 1994).

Despite the above concerns we are aware of little that has been done to characterise the links between work-related health outcomes and safety behaviours or safety performance, at least in the case of bus drivers.

In the next section we use the evidence presented here as the basis for a model of the effect of work stressors on health outcomes and safety performance for the case of the bus driver. The model is presented as a framework from which explicit links between health and safety performance might be drawn through research.

## 4.5 The Duty Fitness Model

In this section we present a model for the investigation of stressor effects on the health, sleep and safety performance of bus drivers working shifts. Section 5 of this report describes a preliminary test of this model.

There are several reasons for a model of the effects of work stressors on bus driver health status and safety behaviour.

Firstly, reviews of research on the effects of stressors on bus driver health are often structured simply by categorizing different factors according to whether they are stressors, mediators or health outcomes (Kompier, 1996a; Tse et al., 2006). In other words relatively little has been done to model how different stressor factors may lead to health outcomes specifically for bus drivers, beyond the general model of stressor

→ mediator → outcome. Thus the different mediators involved, and the dynamic interactions between them, have not been accounted for.

Secondly, we argue that there is a need to model the explicit role which insufficient and irregular sleep could play in the process by which stressors affect job outcomes for bus drivers, especially while more and more bus drivers work in urban environments where societal demands mean there is an ever-increasing need for shift work. Fatigue is a major stressor and needs to be accounted for alongside psychosocial work stressors in explaining health and safety outcomes in bus drivers.

Thirdly, we are not aware of any work done to model the effects of long-term health outcomes on safety performance in bus drivers. A model which outlines the processes which might be involved would be useful in that it would enable relationships between job stressors, sleep, health outcomes and safety performance to be tested and established. This knowledge is required to persuade employers about the benefits of measures to tackle work stressors, using organizational terms that are seen as directly relevant to their business.

The model will need to account for the following points that we have gleaned from the literature review:

- Ultimately the model must describe how work stressors influence health outcomes and thereby safety behaviours.
- It must describe how psychosocial work stressor effects on health are mediated by psychophysiological stress responses.
- The long-term effects of sleep deprivation or irregular sleep, which will often exacerbate poor health outcomes and possibly cause further decrements in safe driving performance, must be accounted for.
- By including fatigue and stress responses in our model, we will need to account for any direct effects they have on safety performance, i.e. effects that are not dependent on poor health outcomes. This will help future research tease apart decrements in safety behaviour that are due to health, fatigue and stress.

Regarding the last point, there is of course ample evidence that fatigue/sleepiness and to some extent stress, each carry direct risks to safe driving[2]. The direct effects of fatigue and psychophysiological stress on safety behaviours are likely to be acute, whereas those mediated by poor health outcomes will be chronic.

Fortunately, the dynamic relations among fatigue, stress, and health status and the role these factors play in relation to safety performance have been considered in a model of the effects of physical exercise on driver performance by Taylor and Dorn

[2] Driver fatigue causes sleepiness and cognitive deficits such as reduced ability to remember, attend, judge and concentrate, and result in several performance reductions such as poor decision making and slower reaction times (Gunzelmann, Gluck, Richard Moore Jr & Dinges, 2012; Phillips & Sagberg, 2010). In fact driver fatigue is thought be responsible for a substantial share (20-30 per cent) of serious road accidents. Direct effects of stress on safe driving are more difficult to delineate, and mainly come from the cognitive challenges of work overload (Brookhuis & De Waard, 2000). There has been some investigation of the links between work demands and short term safety outcomes often in terms of the effect of time pressure on accident rates, and it has been found that bus drivers working under optimal conditions in terms of job demands are less prone to accidents (Evans & Johansson, 1998; Greiner et al., 1998).

(Taylor & Dorn, 2005). This model was evolved according to our findings in the literature by making the changes delineated below.

In their model, Taylor and Dorn include stress as a cause of a psychophysiological response. We contend that stress is more widely accepted as being synonymous with the psychophysiological response, as described by the transactional model of stress (Lazarus & Folkman, 1984)[3]. In line with the transactional model we use the more conventional terms of stressor as cause, stress as response and strain as effect.

Taylor and Dorn's model consider also "daily hassles" or "specific driving events" as (what we call) stressors. We omit these because we want to focus on work stressors that the organization can do something about, by job redesign or participative schedule redesign. Likewise, while we accept that situational and personal characteristics are influential in the effect of work stressors on psychophysiological responses, we do not consider it fruitful to include them in our model explicitly. The presence of other influential stressors inside and outside work will, however, be implicated by the model.

We also consider it important to account for duration of work stressor as playing an important role in disease development, in the same way that some models of organizational stress have done (Beehr, 2000). Stressor duration is therefore clearly implicated in our model.

Taylor and Dorn consider then that the psychophysiological response is a cause of poor health and sleep, rather than that these relationships are reciprocal. Yet we have presented evidence that lack of sleep can exacerbate non-adaptive psychophysiological responses to stressors (see 4.2.3). There is also evidence that poor health can be the result *and* cause of stress, as underpins Levi's ecological model of psychosocially mediated disease (Levi, 1998).

In our model we will therefore consider stress, health and sleep as a triad of dynamic and reciprocally influencing factors that together describe the duty fitness of the bus driver. A problem with one of the factors in the triad will often exacerbate problems with the other two, thus reducing overall duty fitness. Duty fitness may be the best predictor of safety performance, but may itself best be described by attending simultaneously to each of the factors fatigue, stress, and health status.

We have included job-specific wellbeing of the driver as we believe this will also influence job and safety performance. Job-specific wellbeing describes those job attitudes (e.g. job satisfaction) that are largely determined by positive job characteristics (Hackman, Oldham, Janson & Purdy, 1975; Parker, 2002). Job-specific wellbeing will also depend on perceptions of duty fitness. In other words the driver who is well at work will score high on aspects such as work-related health, work motivation and job engagement, and will also perceive few problems with duty fitness. Duty fitness will also have effects on job and safety performance that are independent of wellbeing, i.e. a driver may not necessarily be aware of cognitive or physical decrements that make him or her unfit for work, or may not perceive them as important.

[3] The way threats are appraised depends on the way they are attended to, perceived and evaluated by each individual, a process influenced by factors present in both the environment and in the person. Thus the model is said to depend on a transaction between the person and the environment. Central to the transactional model is that stress outcomes depend on the concept of threat *appraisal* by the individual, rather than the inherent nature of the threat itself. Here a threat is an imagined or anticipated future deprivation of something one values, which is usually related to the self.

Taylor and Dorn include psychological state (mood, emotion) as a mediator of the effect of psychophysiological stress response on driver performance. We consider that temporary changes in mood are something that the organization can do little about through job redesign, while more permanent mood changes that are the result of stressors are likely to encaptured by the model as a health outcome.

The effect of medicine use on driver safety as one result of poor health status is not included explicitly in our model, as it is in Taylor & Dorn's, but it is implicit in the effect of health status on job performance.

We have expanded Taylor and Dorn's original outcome "driving performance" to encompass the main performance domains for bus drivers, i.e. safe driving (and maintenance), punctual driving and customer service (see 4.2.1.2). We consider that the driver may often prioritise one of these in response to poor health, fatigue or stress as a way of coping. This is therefore accounted for by the model.

Safety performance will also be directly influenced by safety climate and culture in the organisation, which includes the values, norms and attitudes of peers and supervisors towards safety, whether the approach to safety is proactive or reactive, and the availability and quality of procedures, documents, training and learning relevant to safety (Fernández-Muñiz, Montes-Peón & Vázquez-Ordás, 2007; Griffin & Neal, 2000; Nævestad, 2008). This influence, while not addressed in this report, may be particularly important for the bus sector in Norway, which has been found to have a poor safety culture relative to other transport modes (Bjørnskau & Longva, 2009).

An important aspect of the transactional model of stress that we do not address explicitly in the model are the *coping* responses that individuals select to deal with stress, a process which will also be influenced by personal and environmental factors and which is thus also transactional (Lazarus & Folkman, 1984). Other authors have elaborated on this theme, adding that organizations can be part of the coping process (Beehr, 2000). As already stated, we are interested in variables the organization can do something about. It is therefore important to consider then that organizational attempts to help individuals cope with stress responses should be included as part of the support structures that are influential in work stressor outcomes, as according to the job control-demands-support models (Karasek & Theorell, 1990).

Finally, our model draws a line between, individual factors, work factors and non-work factors (life outside work). We consider that all factors in the work domain could be measured at organisational level, as predictors of job and safety performance.

The resulting Duty Fitness Model is given in Figure 1.

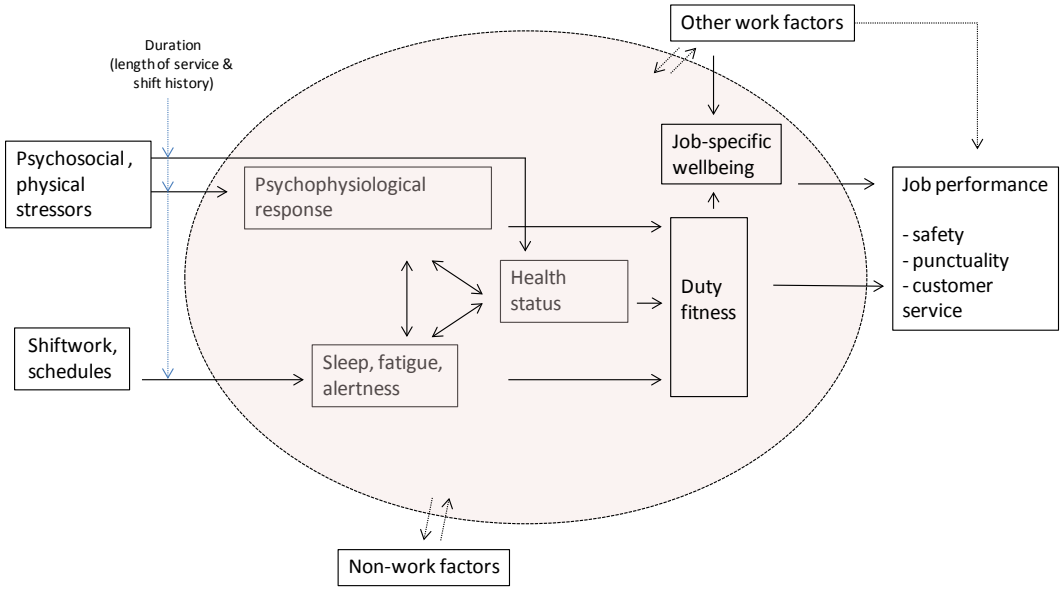



*Figure 1. The Duty Fitness Model. A model of the effect of work stressors on health and safety performance for the bus driver. The pink circle represents the individual. For a description of the model, see text.*

Main psychosocial stressors are high job demands, low job control, and poor social or supervisory support at work, perceived threats, and work-home conflict. Main physical stressors include poor ergonomics and fixed seating position. Shift work and schedule stressors depend on total working hours, break patterns, predictability of schedules, shift type (e.g. day, night, split), and direction of shift rotation. Negative health outcomes for bus drivers are mainly stress disorders (anxiety, depression, high blood pressure), musculoskeletal problems, cardiovascular disease, stomach disorders and chronic fatigue or burnout.

Work stressors will often interact with each other dynamically over time via the dynamic intrapersonal processes shown in Figure 1, to bring about a health effect (e.g. the severity of back pain caused by ergonomic and psychosocial stressors will in part depend on psychophysiological stress response, which may in turn be exacerbated by disturbed sleep). However, health effects may also occur directly (e.g. poor seating position causing back pain over time).

It is expected that the effect of work stressors on health will depend on their duration.

Influences of other factors on the psychophysiological state, sleep and health of the driver that are not accounted for by the model are indicated by the boxes "Other work factors" (e.g. traffic environment) and "Non-work factors" (e.g. family commitments).

Together we consider that health, fatigue status and stress response will together determine duty fitness. Duty fitness describes the cognitive, affective/emotional and physical fitness of the individual for work tasks to be performed, and it will have a direct effect on job and safety performance.

Job and safety performance will also be influenced by job-specific wellbeing, which describes levels of job satisfaction, motivation and engagement. Job-specific wellbeing will in part be influenced by perceptions of duty fitness, and in part by a transaction between job design characteristics and the employee. Job and safety

performance will also depend on the safety culture and climate of the organisation, as indicated by the direct arrow from "other work factors" to "job performance".

Finally, although not indicated explicitly in the model, we accept that job performance may also be a stressor, especially if viewed as inadequate by the individual. In this case the model is circular, i.e. worse job performance leads to more stress, worsened duty fitness, lowered job wellbeing and so on.

# 5 Analysis of a bus driver survey

## 5.1 Aims of the analysis and how it was structured

In this section we describe the analysis of a driver union member survey designed to assess work schedules, time pressure, health outcomes and safety behaviour. The aim of the analysis was two-fold.

Firstly we wanted to map the work situation experienced by bus drivers working split shifts in Norway. As we have seen, split shifts are expected to have undesirable consequences for drivers in terms of health outcomes (see 4.2.3), but these consequences have not been described for Norwegian drivers.

Secondly we wanted examine the influence of work stressors on sleep, health and safety performance of bus drivers, and by doing so carry out a preliminary test of part of the Duty Fitness Model presented in Section 4. The survey did not contain items to assess stress responses, duty fitness or wellbeing, and so a full test of the model was not possible. The testing presented here must therefore be regarded as preliminary.

The compromised model that could be tested using the items available in the union survey is given in Figure 2.

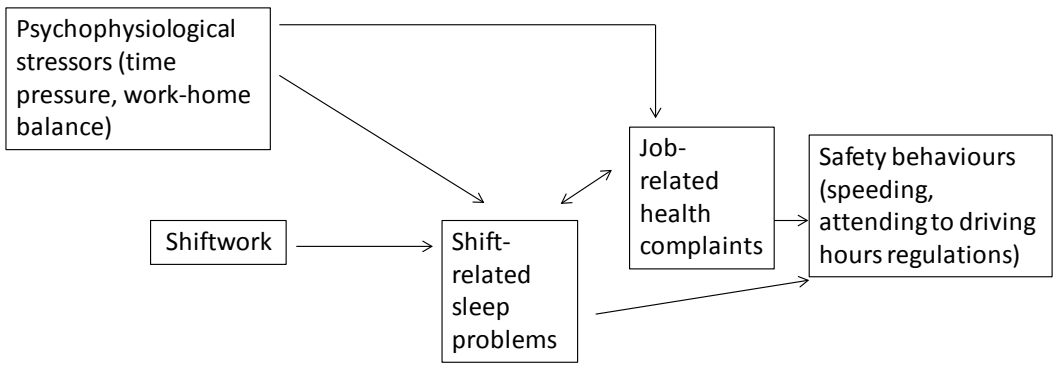



*Figure 2. Compromised version of the Duty Fitness Model for testing using available survey items.*

Psychophysiological stress response is now implicit in the model. Work stressors that could be tested using *post hoc* survey analysis were time pressure at work, and work-home or work-home pressures. Safety behaviours surveyed were speeding due to time pressure and adherence to driving hour regulations.

Below we describe in more detail how the model was tested. Items included in the driver-union survey are then described, followed by the method and the results of our analysis.

## 5.2 Preliminary testing of the Duty Fitness Model

A first part of the analysis was to catalogue the health complaints of our sample, to help determine the extent to which results from our restricted sample of Norwegian bus drivers (see Sample and Survey description, below) could be generalized to other bus drivers (for results see 5.5.1). For similar reasons, we wished to analyse survey responses for indications of the effects of working shifts (versus not working shifts) on health outcomes (for results see 5.5.3). We did not check for the effects of shift work on sleep, because respondents were only asked about shift-related sleep problems in the union survey (see Sample and Survey description).

The model predicts that sleep problems and work demands will, partly through non-adaptive psychophysiological responses, lead to worse health outcomes for the drivers. Thus we would expect that the effects of psychosocial stressors, such as the high demands of driving in congested traffic during rush hour, and work schedule stressors, such as working nights, on health outcomes to be synergistic. Thus we would expect that urban drivers working nights, who face both high psychosocial burden and high sleep burden, would have poorer health outcomes than rural drivers working regular day shifts. In this way the model was used to rank health outcomes for drivers in different job situations (Table 1). The health outcomes of drivers in the different job situations described in Table 1 are presented in our analysis (for results see 5.5.2).

*Table 1. Some hypothetical burdens in short- and long-distance truck and bus operators.*

| **Example of bus driver situation** | **Burden** | | **Health ranking (poorest = 1)** |
|---|---|---|---|
| | **Psychosocial** | **Sleep** | |
| Urban bus (night) | Medium | High | 1 |
| Urban bus (day) | High | Low | 2 |
| Rural bus (night) | Low | High | 2 |
| Rural bus (day) | Low | Low | 3 |

From our analysis of the literature, we expected that drivers in split shift situations would face more demands, and therefore report more sleep and health problems. Survey items were thus analysed to answer the following specific questions: Compared to drivers working other types of shift (continuous morning, afternoon or night shifts), do drivers who work split shifts have:

- longer working hours?
- more shift-related sleep problems?
- more work-related health complaints?
- time pressure while at work?
- more work-home conflict?
- worse safety behaviours?

The results are given in 5.5.4.

In the remainder of the analysis the sample was restricted to those working split shifts so that any variation in sleep problems reported would not be due to different shift type worked. We expected from the Duty Fitness Model that certain work

stressors would be linked to both sleep and health problems (Figure 2). More specifically we wanted to test the following prediction:

- Time-pressure at work and work-family conflict are each related to shift-related sleep problems (for results see 5.5.5.1) and work-related health problems (for results see 5.5.5.2) (for those working split shifts).

While we expected a relationship between work stressors and job-reported health, the model predicts that sleep may partially mediate this relationship. A further prediction to be tested was thus,

- For those working split shifts, variances in work-related health problems that are explained by time pressure at work and work-home conflict are mediated by shift-related sleep problems (for results see 5.5.5.3),

Ultimately, the model predicts that safety behaviours are influenced by health outcomes, and to some extent sleep. Survey items allowed us to formulate the following prediction to be tested:

For those working split shifts and reporting pressure from timetables or delivery deadlines, do shift-related sleep problems or work-related health explain a significant amount of the variance in reports of:

a) speeding due to time pressure (for results see 5.5.5.4)?; and
b) exceeding driving time regulations (for results see 5.5.5.4)?

These questions were answered in two ways.

Firstly, we looked for bivariate relationships between work-related sleep or health outcomes and the safety behaviour in question.

Secondly, in a more rigorous test of the model, we asked whether any demonstrated links between work stressors and the safety behaviour in question were mediated by sleep or health outcomes.

## 5.3 Sample and survey description

A Questback survey was sent by e-mail to 2750 bus driver-members of a Norwegian driver union by union managers in October 2012. Respondent anonymity was guaranteed and the survey did not contain information on background demographics, such as gender and age. The survey was sent to bus and lorry drivers, but responses from the former only were selected for analysis. The number responding was 1183 (43 per cent response rate).

Actual survey items were as follows, after translation from Norwegian.

1. Are you permanently employed? (Yes/No/Other)
2. Would you like permanent employment (Yes/No/Don't know)?
3. Do you have a written employment contract? (Yes/No/Don't know)
4. Where do you work? (Urban/Rural/Both)
5. How many hours do you work in a standard week? (35.5 h/37.5h/other)
6. Do you work shifts? (Yes/No)
7. Do you work split shifts with long breaks in the middle of the day? (Yes/No)
8. Are you satisfied with working split shifts (Yes/No/Other, specify)
9. How often do you work nights (after 9pm and before 6pm)? (Never/Rarely/Monthly/Weekly/Daily)
10. How often do you work on the weekends? (Never/Rarely/Every third week/Every other week/Every week)
11. Do you have a fixed work schedule? (Yes/No)
12. Do you have a predictable working day? (Yes/No)
13. How often do you work over 13 hours a day? (Never/Rarely/Monthly/Weekly/Daily)
14. Agreement with following statements? (1=completely agree; 6=completely disagree)
    i. I have sleeping problems due to shift work/irregular work hours
    ii. My working hours fit well with life outside work (child care, acitivities etc)
    iii. I have enough time to make up for delays
    iv. I have enough time to check the bus before I start the days driving
    v. I have enough time to perform the task I am given
15. I have satisfactory rest/break facilities (Yes/No/not applicable)
16. I have satisfactory toilet facilities (Yes/No/not applicable)
17. Do you experience pressure from route timetables? (Yes/No)
18. How often have you broken the speed limit because of this? (Never/Rarely/Monthly/Weekly/Daily)
19. How often have you broken driving time regulations because of this? (Never/Rarely/Monthly/Weekly/Daily)
20. Do you have health complaints because of your work? (Yes/No/Don't know)
21. Which health complaints do you have because of your work?

There is a lot of variation between roster types used by different companies (see Appendix 1 for examples). Thus a driver answering that they work split shifts may work split shifts all the time or only once or twice a week. From conversation with union representatives, it is our understanding that it is normal for drivers to work a mixture of continuous and split shifts. Such drivers will be included in the grouping "split shift". Drivers who do not work any split shifts at all will be included in the group "other shifts". The latter may work early, day or late shifts, or a mixture of these across a roster.

In item 19. the drivers are asked about Norwegian driving and resting time regulations (*Kjøre- og hviletidsbestemmelsene*), which actually do not apply for drivers of buses on routes of less than 50 km. If drivers were on routes less than 50 km, we assume that they would have interpreted the questions as being about the driving hours regulations that apply to them (*arbeidstidbestemmelsene*).

## 5.4 Analysis method

An SPSS file of individual responses was obtained from Questback, the data screened and cleaned. Dichotomous variables were created from items 14 i-vi, where 1-3 = 0 and 4-6 = 1. Responses for some items were then reverse coded as appropriate for analysis. Item 14 ii was used as a measure of work-home conflict A composite scale "time pressure" was made from the 6-point scales for time to recover from delays, time to carry out maintenance checks and time to carry out the task assigned (see survey items). This scale showed a high level of reliability (Cronbach's alpha = .81). Results for the individual and composite scale are reported. The composite scale was used in regression analysis for testing model predictions.

All bus drivers who did not have a standard average working week of 35.5 h or 37.5 h were excluded from the analysis. Otherwise working hours were controlled for where it was thought that the difference between 35.5 h and 37.5 h could influence the results.

Results are reported as significant where chi-squared tests indicated that there were differences in shares of respondents answering in each group (alpha level .05), or where an indpendent t-test indicated that there was a difference in the average scale score between two groups (alpha level .05). Comparisons were made either between those working and not working shifts, or between those who worked split shifts and those who just worked other types of shift.

Qualitative comments on the type of health complaint (in response to item 21. above) were coded into categories emergently by the researcher.

For statistical analyses using standard multiple regression, preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity. For logistical regressions, variance in dependent variable explained by a model is given using Nalgerke R square, which is regarded to be more easily interpreted than Cox's R square.

## 5.5 Results

### 5.5.1 Nature of health outcomes

A third of respondents (33 per cent) reported that they had a work-related health problem.

Qualitative descriptions of work-related health problems reported in open responses by drivers resemble those described in the literature in Section 3. The main categories were as follows and are given for all responding drivers working either a 35.5 h or 37.5 h working week, regardless of shift:

- musculoskeletal problems related to the neck, shoulders back or knees (mentioned by 61 per cent of those who said they had a health problem).
- stress or sleeping problems with an associated musculoskeletal problem (20 per cent).
- other physical outcomes, including stomach complaints (8 per cent).
- poor sleep or sleep disorder (5 per cent).
- stress symptoms alone (4.4 per cent).
- heart problems (1.9 per cent).

### 5.5.2 Differences in health outcomes according to job situation

The Duty Fitness Model predicts that health outcomes depend on a combination of psychosocial and sleep burdens. As outlined in Table 1, a simple prediction of the model is that a greater share of those drivers on urban routes, which are expected to produce high psychosocial burden due to traffic demands, and working nightshifts, which are expected to produce the greater sleep burden, will report poor health outcomes when compared to drivers in other job situations.

Table 2 shows the share of urban and rural drivers reporting health problems, according to whether or not they work nights. Note that the analysis is limited to those drivers working shifts.

A high share of urban drivers working nights daily, weekly or monthly reported poor health outcomes (46 per cent). Compared to other groups this group had by far the highest share of poor health outcomes related to work.

The next greatest prevalence of poor health outcomes is among "night" drivers working urban-and-rural routes. The prevalence of poor health outcomes is lowest among drivers working only rural routes.

In the case of the rural drivers, as opposed to the urban drivers, there does not appear to be much effect of working nights.

*Table 2. Survey item responses for bus drivers who work urban, rural or both types of environment, divided according to frequency of nightshifts worked. Only shift workers are included. Nightshifts are worked between 21:00 and 06:00 h.*

| Type of route driven | How often do you work nights? | % work-related health problems | n | % working 37,5 h per week | n | % working split shifts | n |
|---|---|---|---|---|---|---|---|
| Urban mainly | Never/rarely | 33.8 | 65 | 32.9 | 255 | 64.3 | 255 |
| | Daily/weekly/monthly | 46.3 | 188 | | | | |
| Urban & rural | Never/rarely | 33.1 | 127 | 38.4 | 463 | 64.0 | 461 |
| | Daily/weekly/monthly | 36.9 | 336 | | | | |
| Rural mainly | Never/rarely | 24.1 | 54 | 40.5 | 111 | 73.9 | 111 |
| | Daily/weekly/monthly | 22.8 | 57 | | | | |

The shares of urban, urban-and-rural and rural drivers working longer (37.5 h versus 35,5 h) weeks and working split shifts is also given in Table 2, to show how variation in health problems might have been caused by variations in these factors. There are no indications that the difference in work-related health problems was due to varying working hours, since the rural drivers, who have the lowest share of health problems, work the longest weeks and have the greatest share of split shifts[4] (Table 2).

The main conclusions from this part of the analysis are that:

a) more of the drivers working in mainly urban environments have work-related health problems; and
b) health problems are most common among those urban drivers more frequently working nights.

### 5.5.3 Differences in survey responses according to shift work

Average responses on survey items grouped according to whether or not the drivers worked shift are given in Table 3.

There was a large variation in whether the average number of hours worked per week was 35.5 or 37.5, across shift groupings. Most of those who did not work shifts worked 37.5 h a week, while less than half of those on shifts worked 37.5 h a week[5].

[4] While it may appear surprising that a greater share of rural drivers work split shifts, which after all are designed to deal with rush hour demands, it must be remembered that the analysis here is restricted only those working shifts. The share of rural drivers working shifts was 65 per cent, versus 85 per cent for urban drivers working shifts. Thus at least in this sample, a rural driver who works shifts is more likely to work split shifts.

[5] It should be remembered that there is a lot of variation from week to week about the average number of hours worked per week, whether the average is 35.5 or 37.5 h (see Appendix 1).

*Table 3. Survey item responses for bus drivers who do not work shifts (Non-shift) and those who work shifts (Shift). Responses for those who work shifts are further divided into those who work split shifts and those who work other types of shift. Tests of statistical significance are presented for differences in the percentage shares of "non-shift" versus "shift"; and "split shift" versus "other shift".*

| | Non-shift | | Shift | | Split shift | | Other shift | |
|---|---|---|---|---|---|---|---|---|
| **Item summary** | **%** | **n** | **%** | **n** | **%** | **n** | **%** | **n** |
| Work 37,5 h per week | 76.8*** | 164 | 37.0*** | 827 | 43.6*** | 541 | 24.8*** | 286 |
| Problems sleeping due to shift work / irregular hours | n/a | n/a | 43.4 | 825 | 46.2* | 539 | 38.1* | 286 |
| Work-related health problems | 25.6** | 164 | 36.4** | 825 | 40.6*** | 539 | 28.3*** | 286 |
| Insufficient time to recover from delays | 37.1*** | 151 | 60.8*** | 816 | 63.3 | 532 | 56.3 | 284 |
| Insufficient time to check the vehicle before starting | 39.1*** | 151 | 60.2*** | 818 | 62.8 | 532 | 55.9 | 286 |
| Insufficient time to carry out the task I am given | 31.2*** | 154 | 52.2*** | 823 | 55.3* | 537 | 46.9* | 286 |
| Pressure from route timetable or delivery deadlines | 51.6*** | 157 | 71.3*** | 824 | 74.9** | 538 | 64.7** | 286 |
| Problems balancing work and home life | 39.3*** | 163 | 54.2*** | 821 | 58.5*** | 537 | 45.8*** | 284 |
| Break speed limit once a week or more[1] | 40.5 | 79 | 51.6 | 586 | 51.0 | 402 | 53.3 | 184 |
| Break driving time regulations at least once a month[1] | 11.5* | 78 | 23.3* | 582 | 24.1 | 399 | 21.9 | 183 |

[1] Due to pressure from timetable or delivery deadlines, of those reporting pressure from timetable or delivery deadlines. Number responding to these items is lower because we have selected out those not reporting that they have pressure from route timetable or delivery deadlines. *p<.05; **p<.01; ***p<.001.

The share of drivers working shifts who agreed that they have problems sleeping due to shift work or irregular working times was 43 per cent. We could not compare sleeping problems for shift workers with those for drivers not working shift, because the relevant question had been worded by the union such that it was specifically about sleep problems due to shift work.

Of those who worked shift, 36 per cent reported that they had a work-related health problem. This share was significantly higher than it was of those who did not work shift (26 per cent), whether or not the average number of hours per week was controlled for.

In response to a dichotomous question (requiring a yes/no response), 71 per cent of those working shift said they experienced time pressure due to timetables, against 52 per cent of those not working shift. This is probably because shift work is more common in the city, where bus routes are more frequent and where drivers therefore experience more time pressure. Significantly greater shares of those working shifts than those who did not work shifts also reported some level of agreement that they had (i) insufficient time to recover from delays, (ii) carry out maintenance checks and (iii) carry out the task they were given. On the composite scale "time pressure" (comprising responses on i.-iii,), where 1 indicates a high level of disagreement and 6 indicates a high level of agreement about experienced time pressure, the mean scores were 2.9 for those who did not work shift and 3.9 for those working shift, $t(963) = -7.3$, $p<.001$.

A greater share of those working shifts reported that they had problems balancing work and home life, compared with those not working shifts.

Given the differences in work stressors and health outcomes, it is interesting as regards the Duty Fitness Model to see if there are differences for safety behaviour for shift workers. The results in Table 3 show that *out of those reporting pressure from timetables*, a greater share of those working shifts reported that they drove over the speed limit because of this pressure. Although the difference in shares was not significant, there was a significant difference in mean scores on the full scale for the two groups, $t = (676)\ -2.20$, $p<.05$. In addition, of those reporting pressure from timetables, the share of shift workers reporting that they broke driving time regulations at least once a month on account of this pressure, was significantly greater than it was for those who did not work shifts.

### 5.5.4 Differences in survey responses according to shift type

Shares of responses on different survey items for those working split versus other types of shift are also given in Table 3.

The share of drivers working shifts who agreed that they have problems sleeping due to shift work was significantly higher for those working split shifts than it was for those working other shifts (Table 3). The mean score on the full 6-point scale measuring sleep problems was also higher for the split shift group (see section 0 for treatment of scale items). Although not shown in Table 3, analysis showed there was no difference in problems sleeping due to shift work according to average number of hours per week. This suggests that the difference in sleeping problems according to shift type is not explained by the higher number of average hours worked by the split shift group.

There was a large and significant difference in the share who reported that they had a work-related health problem according to shift type worked, with 40 per cent of those working split shifts reporting work-related health problems, compared with only 28 per cent of those working other types of shift. Again this was not due to differences in the number of hours worked.

In response to a dichotomous question (requiring a yes/no response), 75 per cent working split shifts said they experienced time pressure due to route timetables, compared with 65 per cent working other types of shift.

The share of those working split shifts who reported insufficient time to recover from delays was not significantly different from those working other shifts, although a t-test conducted on the mean scores on the full 6-point scales for the two groups was significant, $t = -2.9\ (816)$ $p<.01$, indicating that those working split shifts had less time to recover from delays. There were no differences on time to carry out maintenance according to shift type for those working shifts. However, a significantly greater share of those working split shifts reported that they had insufficient time to carry out the task they had been given, when compared with those working other types of shift.

On the composite scale "time pressure", where 1 indicates a high level of disagreement and 6 indicates a high level of agreement about experienced time pressure, the mean scores on the time pressure scale were 4.0 for those working split shifts and 3.7 for those working other shifts, $t\ (812) = -2.77$, $p<.01$.

Of those working shifts, a greater share of those working split shifts reported problems balancing work and home life.

Of those reporting pressure from timetables and working shifts, there was no difference in either speeding or exceeding driving time regulations according to the type of shift worked.

### 5.5.5 Links between sleep, health and safety in split-shift workers

An underlying assumption behind the Duty Fitness Model (section 4.5) and the predictions formulated as a preliminary test of the model (section 5.2) is that sleep problems and health problems are related.

A significant bivariate correlation between work-related health problems and shift-related sleep problems confirmed a significant relationship for our sample ($r = .33$, $p<.001$).

An alternative analysis of the relationship between shift-related sleep problems and work-related health is given in Table 4, which shows that 53 per cent of shift workers who agreed that they had shift-related sleep problems also report a work-related health problem, whereas health problems are reported by only 24 per cent of shift workers who disagreed that they had a sleep problem. A similar pattern was found for the split shift workers (Table 4).

*Table 4. Percentage of bus drivers who work shifts reporting work-related health problems, according to whether or not they report problems sleeping due to shift work.*

| Work-related health problems? | All shift workers | | | | Split shift workers | | | |
|---|---|---|---|---|---|---|---|---|
| | Shift-related sleep problems? | | | | Shift-related sleep problems? | | | |
| | % agree | n | % disagree | n | % agree | n | % disagree | n |
| Yes | 52.6 | 356 | 23.9 | 170 | 55.0 | 137 | 28.3 | 82 |
| No / Don't know | 47.4 | 112 | 76.1 | 189 | 45.0 | 112 | 71.7 | 208 |
| Total | 100 | 468 | 100 | 359 | 100 | 249 | 100 | 290 |

Having confirmed the assumption that sleep and health are related, results from testing the remaining predictions laid out in section 5.2 are as follows.

#### 5.5.5.1 Are time pressure at work and work-home conflict linked to shift-related sleep problems?

Standard multiple regression was used to assess the ability of the work stressors work-home conflict and time pressure at work to predict shift-related sleep problems reported by those working split shifts, after controlling for hours worked. Here, the full response scale (level of agreement from 1 to 6) for shift-related sleep problems was used as the dependent variable.

Hours of work was entered at Step 1, and was not significantly related to the variance in shift-related sleep problems. After entry of work-home conflict and time pressure at work at Step 2 the total variance explained by the model as a whole was 15.0 per cent, $F (3, 523) = 31.90$, $p<.001$. Statistics for the model after Step 2 are given in Table 5.

*Table 5. Standard multiple regression analysis of work-home conflict and time pressure at work as predictors of shift-related sleep problems reported by those working split shifts, controlling for hours worked.*

| Predictor variable | B[1] | SE B | beta | t | sig. |
|---|---|---|---|---|---|
| (Constant) | 1.024 | .308 | | 3.322 | .001 |
| Hours of work | .131 | .145 | .036 | .906 | .365 |
| Time pressure | .228 | .056 | .179 | 4.08 | <.001 |
| Work-home conflict | .310 | .048 | .281 | 6.391 | <.001 |

[1]B = unstandardised beta coefficient, SE B is the standard error, beta is the standardized beta coefficient, t is the t-test statistic, and sig. is the level of significance.

Work-home conflict and time pressure at work explain 14.9 per cent of the variance in shift-related sleep problems, after controlling for hours worked. The beta values indicated that work family conflict was a stronger predictor of sleep problems than time pressure at work (Table 5).

#### 5.5.5.2 Are time pressure at work and work-home conflict linked to work-related health problems?

Direct logistic regression was used to assess the impact of a number of factors on the likelihood that respondents would report that they had a work-related health problem. The model contained three independent variables: hours worked, work-home conflict and time pressure at work. The full model containing all three factors was statistically significant, chi squared (3, N = 527) = 50.48, p<.001, indicating that the model was able to distinguish between those who reported a work-related sleep problem and those who did not. The model as a whole explained 12.4 per cent of the variance in work-related health problems, and correctly classified 68.1 per cent of cases. As shown in table 6, only work-home conflict and time pressure at work made a unique statistically significant contribution to the model.

*Table 6. Logistic regression predicting likelihood of reporting a work-related health problem. Model 1.*

| | *B* | S.E. | Wald | *df* | *p* | odds ratio | 95% C.I. for Odds Ratio | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Hours worked | .03 | .19 | .03 | 1 | .850 | 1.03 | .72 | 1.50 |
| Time pressure at work | .30 | .07 | 16.7 | 1 | <.001 | 1.36 | 1.17 | 1.57 |
| Work-home conflict | .24 | .06 | 13.8 | 1 | <.001 | 1.27 | 1.12 | 1.44 |
| Constant | -2.63 | .43 | 36.9 | 1 | <.001 | .07 | | |

The strongest predictor of work-related health was time pressure at work, with an odds ratio of 1.36.

#### 5.5.5.3 Are the effects of work stressors on health mediated by shift-related sleep problems?

The Duty Fitness Model predicts that the effects on health of time pressure at work and work-home conflict will to some extent be mediated by the sleep problems that they cause. If this is the case we would expect that a substantial share of the variance in work-related health that they explain would be negated when we control for shift-related sleep problems.

This was tested by adding shift-related sleep problems as an additional independent variable in the direct logistic regression reported in Table 6.

Inclusion of shift-related sleep improved the model[6] i.e. the new model explained a substantially greater amount of variance in health problems, with 19.7 per cent of the variance in work-related health problem being explained, and 68.7 per cent of cases being correctly classified (cf 5.5.5.2).

Comparison of the beta values in table 7 with those in table 6 shows that the contributions to work-related health of the work stressors time pressure and work-home balance have been reduced, but remain significant. However, the strongest predictor of work-related health in the expanded model was shift-related sleep problems, with an odds ratio of 1.39.

*Table 7. Logistic regression predicting likelihood of reporting a work-related health problem. Model 2.*

| | *B* | S.E. | Wald | *df* | *p* | odds ratio | 95% C.I. for Odds Ratio | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Hours worked | -.01 | .20 | .003 | 1 | .96 | .99 | .68 | 1.45 |
| Shift-related sleep problem | .33 | .06 | 31.1 | 1 | <.001 | 1.39 | 1.24 | 1.56 |
| Time pressure at work | .25 | .08 | 10.4 | 1 | .001 | 1.28 | 1.10 | 1.49 |
| Work-home conflict | .14 | .07 | 4.4 | 1 | .04 | 1.15 | 1.01 | 1.32 |
| Constant | -3.1 | .46 | 45.7 | 1 | <.001 | .05 | | |

The evidence thus supports the notion that the effects of work stressors on work-related health are mediated by shift-related sleep.

#### 5.5.5.4 Are shift-related sleep problems and work-related health problems linked to safety behaviour?

The ultimate prediction of the model is that health and sleep outcomes are linked to safety behaviour. Preliminary analysis of bivariate correlations confirmed a significant relationship between shift-related sleep problems and both speeding due to time pressure ($r = .13$, $p < .05$) and exceeding driving time regulations due to time pressure ($r = .11$, $p < .05$), for those split shift workers experiencing time pressure. Furthermore, there was a significant relationship between work-related health problems and both speeding due to time pressure ($r = .12$, $p < .05$) and exceeding driving time regulations due to time pressure ($r = .12$, $p < .05$).

Following preliminary analysis a more rigorous analysis was carried out to answer the above question, for the case of a) speeding, and b) driving contrary to driving hours regulations.

a) Speeding

Standard multiple regression was used to assess the ability of shift-related sleep problems and/or work-related health problems reported *by those working split shifts and reporting pressure from timetables* to account for speeding behaviour, after controlling for hours worked and work-home conflict.

[6] The full model containing all four factors (hours worked, shift-related sleep problems, time pressure at work and work-home conflict) was statistically significant, chi squared ($4, N = 527$) = 83.1, $p < .001$.

Hours worked and work-home conflict were entered at Step 1, and were significantly related to the variance in shift-related speeding. The total variance explained by hours worked and work-home conflict together was 2 per cent, F (2, 401) = 3.9, p = .02. Only work-home conflict explained a significant amount of variance in pressure-related speeding behaviour (Table 8).

Addition of either shift-related sleep problems or work-related health problems at Step 2, or entry of both factors together, did not result in a significant change in the total variance in speeding behaviour explained by the model (data not shown).

Statistics for the model after Step 1 are given in Table 8.

*Table 8. Standard multiple regression analysis of work-home conflict as a predictor of speeding behaviour reported by those working split shifts, after controlling for hours of work.*

| Predictor variable | B[1] | SE B | beta | t | sig. |
|---|---|---|---|---|---|
| (Constant) | 2.807 | .261 | | 10.764 | <.001 |
| Hours of work | .002 | .134 | .001 | .018 | .985 |
| Work-home conflict | .116 | .042 | .138 | 2.768 | .006 |

[1]B = unstandardised beta coefficient, SE B is the standard error, beta is the standardized beta coefficient, t is the t-test statistic, and sig. is the level of significance.

b) Driving contrary to driving hours regulations

Standard multiple regression was used to assess the ability of shift-related sleep problems and/or work-related health problems reported by those working split shifts to account for reports of exceeding the driving time regulations, after controlling for hours worked and work-home conflict.

Hours worked and work-home conflict were entered at Step 1, and were significantly related to the variance in reports of exceeding the driving time regulations. The total variance explained by hours worked and work-home conflict together was 2 per cent, F (2, 395) = 3.4, p = .03. At this stage only work-home conflict explained a significant amount of the variance in reports of exceeding the driving time regulations (Table 9).

Addition of work-related health problems at Step 2 resulted in a small but significant change in the variance of driving hours transgressions explained by the model, R square change = 1 per cent, F (1, 394) = 4.1, p=.04 (Table 9).

Addition of shift-related sleep problems at Step 2, or entry of both sleep and health problems together, did not result in a significant change in the total variance in reports of breaking work-time regulations explained by the model (data not shown).

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*Table 9. Standard multiple regression analysis of work-home conflict as a predictor of driving hours transgressions reported by those working split shifts, after controlling for hours of work.*

| Model | Predictor variable | B[1] | SE B | beta | t | sig. |
|---|---|---|---|---|---|---|
| 1 | (Constant) | 1.682 | .202 | | 8.314 | <.001 |
| | Hours of work | .097 | .104 | .047 | .939 | .349 |
| | Work-home conflict | .077 | .032 | .119 | 2.384 | .018 |
| 2 | (Constant) | 1.651 | .202 | | 80172 | <.001 |
| | Hours of work | .088 | .103 | .042 | .85 | .396 |
| | Work-home conflict | .064 | .033 | .098 | 1.924 | .055 |
| | Work-related health problems | .211 | .105 | .102 | 2.013 | .045 |

[1]B = unstandardised beta coefficient, SE B is the standard error, beta is the standardized beta coefficient, t is the t-test statistic, and sig. is the level of significance.

# 6 Overall summary and conclusion

## 6.1 Summary

This report describes a literature review and *post hoc* analysis of a survey of 1183 bus drivers working in Norway, carried out to explore links between work stressors, health outcomes and safety behaviours.

We found evidence in the literature that work-related health complaints and health-related organizational outcomes are more prevalent among bus drivers than most other occupations.

The main causes are psychosocial stressors. In particular, low control is in part inherent to the bus driver task, where goal achievement (e.g. arriving on time) is threatened by both competing demands and unpredictable events in the road environment. However, physical stressors and sleep pressure and pressure on home life from work schedules also play a major part in health outcomes for the bus driver. Psychosocial, physical and sleep stressors will often be present simultaneously, and have confounding affects on health outcomes.

The nature of work-related health decrements for bus drivers are typically categorized as stress related psychological disorders and associated physical symptoms (especially elevated blood pressure), musculoskeletal problems, cardiovascular disease, stomach and related gastrointestinal problems, and chronic fatigue or burnout.

One in three of the respondents in our survey sample reported that they suffered from a work-related health problem, and the profile of complaints was in line with that found in the literature. Notably, 81 per cent of health problems reported by our sample were musculoskeletal in nature, with or without associated stress problems.

Bus drivers in the survey sample also resembled those studied in the occupational literature in that work-related health problems were more abundant among those working shifts, of which 36 per cent reported problems, than those not working shifts, of which 26 per cent reported problems.

We found that work stressors were also more abundant among bus drivers working shifts. These were namely:

- time pressure on the job (52-61 per cent reported experiencing time pressure compared with 31-39 per cent of those not working shifts), and;
- conflict between work and home (54 per cent compared with 39 per cent of those not working shifts).

We were unable to assess whether sleep problems were more abundant for shift workers than for those not working shifts, because survey items had been worded by the union responsible for the survey to address specifically *shift-related* sleep problems.

Given the prevalence and nature of health outcomes in our sample, and that both work stressors and health decrements were more abundant for shift workers, we can regard the survey sample as being fairly representative of the bus driver situation

conveyed by international literature. However, it is important to remember that the sample contains a mix of rural and urban drivers, who experience different levels of demands.

There is reason to believe from the literature review that health outcomes may be detrimental to safety performance, not least due to associated health behaviours (e.g. use of medication) or the cognitive decrements associated with many health problems. Given the greater shares of shift workers reporting work stressors and poor health outcomes, we might therefore expect that problematic safety behaviours would also be more abundant among those working shifts.

To assess this we analysed responses on survey items assessing the safety behaviours a) speeding and b) breaking driving hours regulations. Of those who experienced pressure from timetables, 23 per cent of shift workers reported breaking driving time regulations, a share which is significantly greater than the 12 per cent of those not working shifts. This difference was not explained by the fact that the shift workers in our sample tended to work more hours. However, we found no significant differences in the corresponding shares reporting speeding once a week or more.

Split shifts have been reported to be a particularly challenging type of shift for bus drivers. Accordingly, greater shares of drivers working split shifts in our sample reported undesirable levels of work stressors, sleep pressure and poor health outcomes. The specific differences were as follows:

- 55 per cent of split shift drivers reported having insufficient time to carry out tasks, versus 47 per cent of drivers working other types of shift.
- 75 per cent reported pressure from route timetables, versus 65 per cent of drivers working other shifts.
- 59 per cent reported problems balancing work and home life, versus 46 per cent of drivers on other shifts.
- 46 per cent reported shift-related sleep problems, versus 38 per cent of drivers on other shifts.
- 41 per cent reported work-related health problems versus 28 per cent of drivers on other types of shift.

However, there were no significant differences in the shares of those working split versus other shifts reporting undesirable safety behaviours.

To structure further investigations into any common causes of the poor health outcomes and undesirable safety behaviours seen for shift workers, a model was presented describing how work stressors (psychosocial stressors, physical stressors, schedules and shift work) together influence a triad of dynamically interacting duty fitness factors – psychophysiological response, health outcomes and sleep – which in turn influence the safety performance of bus drivers (Figure 1). The remainding analyses were carried as a preliminary test of this so-called Duty Fitness Model.

The Duty Fitness Model predicts rankings of poor health outcomes according to the different job situations of bus drivers. For example, the model predicts that poor health outcomes will be more abundant for drivers working urban routes and frequently working nights than they are among drivers on rural routes rarely working nights, because psychosocial stress response and sleep deficit are likely to be greater for the former, and the two different types of stressor will have additive or synergistic effects on health. Analysis of the survey responses supports this prediction, by showing that the share of urban drivers frequently working nights and

reporting work-related health problems (46 per cent) is almost twice as great as the corresponding share for rural drivers who rarely or never work nights (24 per cent).

Although the frequency of nightshifts worked makes little difference to the share of rural drivers reporting health problems, there is a marked difference in the share of urban drivers reporting health problems depending on whether they worked nights often (46 per cent reported problems) or not (34 per cent reported problems). This implies that the effects of demanding schedules on health outcomes may depend on the level of other work stressors the driver is subjected to (i.e. demands of urban driving), thus supporting the idea that it is important to attend to several duty fitness factors together when considering work-related health outcomes affecting safety.

While it is expected from the Duty Fitness Model that the health outcomes for drivers in the different job situations above will also be associated with variations in safety behaviour, we were unable to test this specifically, because of the wording used in the pre-existing survey items[7].

The remainder of the analysis carried out to test the model was carried out only on split shift drivers.

To begin with we confirmed an underlying assumption of the Duty Fitness Model, which is that work-related health problems are linked to shift-related sleep problems.

Using regression analyses, we then found that work-related time pressure and work-home balance were each responsible for a significant and substantial variation in the amount of a) shift-related sleep problems and b) work-related health problems reported by those working split shifts. This was also in line with the Duty Fitness Model.

Further analysis indicated that the effects of work-related time pressure and work-home balance on work-related health are partially mediated by shift-related sleep problems. Again this is in line with the Duty Fitness Model, which states that the effects of psychosocial work stressors on health are mediated by sleep and by psychosocial stress responses.

Finally, links between health outcomes and safety behaviour were investigated by standard multiple regression analyses.

For those working split shifts and reporting time pressure due to route timetables, the level of work-home conflict was responsible for a significant variation in reports of the following safety behaviours: a) speeding due to time pressure, and b) breaking driving time regulations due to time pressure.

Addition of neither shift-related sleep problems nor work-related health problems resulted in a significant change in total variance in speeding behaviour explained.

Addition of shift-related sleeping problems did not result in a significant change in the total variance of driving hours transgressions. However, addition of work-related health problems resulted in a small but significant change in the total variance of driving hours transgressions, in the expected direction.

[7] Survey items were already worded by the union who issued the survey. Items on safety behaviour were "How often have you broken the speed limit because of [pressure from route timetables]?", and "How often have you broken driving time regulations because of [pressure from route timetables]?" Thus only a subsample of drivers from the groups , i.e. those experiencing pressure from timetables are surveyed on safety behaviour. This prevents us being able to test the safety behaviour reported by *all* urban drivers often working nights, and so on.

Thus we can say that preliminary analyses show tenuous evidence that the links between work stressors and safety behaviours are mediated by psychosocial response, sleep and work-related health, as predicted by the Duty Fitness Model.

## 6.2 Discussion and conclusion

Before we go on to consider support for and against the model, it is important that the study's methodological limitations are considered.

This study exploits *post hoc* a union survey of bus drivers that had been distributed and collected before the analysis began. The main limitation of the study is thus that the survey questions were not optimal for preliminary testing of the model presented here.

One consequence of this is that because drivers were asked about shift-related sleep problems, we do not know about the effects of working shifts on sleep, and cannot validate that the shift-sleep problem exists for our sample. Another problem is that there were no questions on psychophysiological stress response, a key factor in the model. A further problem relates to uncertainty about driver interpretations of driving hours regulations (see bottom of page 23).

Some of the language used in the survey items may also have been construed by the respondents as leading, especially given that the survey is sent out by their union e.g. respondents were asked to indicate their level of agreement with the statement "I have sleeping problems due to shift work", but it would have been preferable if they were asked "Do you have trouble sleeping at night?", followed by "To what extent do you think this is due to the shifts that you work?". Future surveys would be improved by being designed and distributed by an independent body.

Another limitation of the study is that the sampling was opportunistic. All drivers are members of a single professional driver's union. We cannot therefore generalize the results here to bus drivers in general, or even bus drivers in Norway.

Finally, there may well be systematic differences with respect to age or length of service of those who do and do not work urban routes, do and do not work shifts, and those who work split versus other types of shift. The union survey did not include demographic variables and so we could not control for these factors in our analysis. This does not however detract from attempts to find relationships between stressors, health, sleep and safety outcomes. Presumably these links exist independent of age, as long as there has been a reasonable period of service. Nevertheless, by including survey items on demographics and length of service, future surveys could clearly improve on the current analysis.

For the above reasons, the results reported here must therefore be regarded only as a preliminary test of the model.

In addition there are some theoretical limitations to point out.

In the first part of the report we review the nature, prevalence and causes of poor health outcomes for bus drivers, and find several reasons why they may be linked to safety behaviours. As we mention in the Introduction, there are of course many other influences on bus driver safety behaviour other than those at the individual level, such as organizational safety culture or the nature of the traffic environment. Even at the individual level, there will be influences on safety behaviour that we did not include explicitly in the Duty Fitness Model (e.g. age, locus of control, personality

type, hardiness, negative affectivity or gender). These factors cannot be addressed through job redesign, and so were not in focus in this report. They may nevertheless be important in determining the quality and degree of health and safety outcomes that are the result of a certain set of job stressors.

A further theoretical point is that the number of work stressors and safety behaviours that could be investigated was limited. A full test of the Duty Fitness Model requires that a broader range of work stressors and safety behaviours be assessed. A particular problem in terms of assessing the Duty Fitness Model is that self-reports on speeding and driving hours transgressions do not capture important aspects of safety behaviour that we expected to be influenced by poor health, i.e. vigilance, attention, reaction time and so on.

Last, at not least, there are issues of causality, the most obvious being that work-home balance could well be the effect rather than the cause of driving hours transgressions. Such problems are, however, inherent to any cross-sectional survey analysis acting as a precursor to longitudinal studies.

We now consider support for the Duty Fitness Model.

Indirect support for the model comes from the finding that the share of bus drivers in job situations consistent with greater psychosocial and sleep burden reporting health problems is greater than the corresponding share of bus drivers in job situations consistent with lower psychosocial and sleep burden. We also found that work stressors and poor health outcomes were more abundant for shift than non-shift drivers. Moreover, 23 per cent of shift drivers with time pressures break driving time regulations, compared with only 12 per cent of non-shift drivers (with time pressures).

More direct support comes from regression analysis of responses from split shift drivers. There was a positive relationship between work stressors[8] and a) sleep problems b) health outcomes. Regression analysis also indicated that the link between work stressors and health outcome was partially mediated by sleep problems, which is in line with the model.

Ultimately the Duty Fitness Model predicts that work stressors result in poorer safety behaviour. Regression analyses indeed indicate that work home conflict is responsible for a significant amount of the variance in speeding and breaking driving time regulations due to time pressure. This finding is all the more striking given that work home conflict was ultimately the only stressor variable we could test given the limitations of the pre-formulated survey items.

We found no evidence using the current analyses that the link between work stressors and safety behaviour is mediated by sleep problems, although there was tenuous evidence that the link is mediated by health outcomes. There are three explanations for the weakness of the evidence for mediation of the link between work stressors and safety behaviour by sleep and health quality.

Firstly, the Duty Fitness Model allows for direct effects of stress on safety behaviour. If the direct effects are stronger than indirect effects, which are those that are mediated by the poor health outcomes caused by stress, then we might indeed expect the results that we found, i.e. a clear link between work stressor and safety behaviour, and tenuous evidence that this link is mediated by health outcomes.

[8] A composite measure of time pressure, and work life balance.

Secondly, it is not unreasonable to expect that psychophysiological stress response may be the main duty fitness factor mediating between work home balance and safety behaviour, and this would not have been accounted for by our limited analyses.

Thirdly, the analysis is limited by the use of work-home balance as representative of all work stressors and the use of speeding and driving hours transgressions as representative of all safety behaviour. Had we been able to include a range of psychosocial (e.g. customer demands, time pressure or peer support) and physical work stressors (e.g. time spent sitting) and more relevant safety behaviours (i.e. those demanding a greater degree of vigilance, attention or other cognitive performance) we may have found that the effect of work stressors on safety outcomes was indeed mediated by health outcomes.

Lastly, as described in section 4, there are many other influences on safety behaviour than work stressors, health and sleep, e.g. safety culture, individual factors, that we do not account for here.

On balance therefore we contend that the results arising from the limited analysis here support further investigation of the need to account for health as a potential factor in safety performance. This should be done using a survey tool that is specifically designed to test the model presented here, using a representative sample of drivers, who are also surveyed on demographics. Positive findings from a robust survey study would provide support for a longitudinal study into the effects of work stressors on health, sleep, and eventually safety behaviour.

Fatigue, stress and health have mostly been considered as separate factors in relation to both driver health and driver safety, despite the fact that these factors are strongly and dynamically interactive. Likewise, while psychosocial pressures are often cited in relation to health outcomes, sleep undoubtedly plays a role in the effects of these stressors.

Our hope is therefore that this is the first of several studies that will contribute towards a more integrated approach.

Independent of any consequences on safety behaviour, the results support a need for organizations to attend to and improve bus driver health, not least by attending to organizational causes of poor health, such as work stressors and shift schedules. The different demands faced by bus drivers in different job contexts (rural and urban) should be considered during this process.

# 7 References


Amundsen, A. H. & Sagberg, F. (2003). *Hours of service regulations and the risk of fatigue- and sleep-related road accidents* (No. 659/2003). Oslo: Institute of Transport Economics.

Anderson, R. (1992). The back pain of bus drivers: Prevalence in an urban area of California. *Spine, 17*(12), 1481-1488.

Aptel, M. & Cnockaert, J. C. (2002). *Stress and work-related musculoskeletal disorders of the upper extremities*: The European Trade Union Technical Bureau for Health and Safety.

Aronsson, G. (1982). *Sickness absence for local public transport personnel at Stockholm transport* (No. Report Number 33). Stockholm: University of Stockholm, Department of Psychology.

Barber, L. & Munz, D. C. (2010). Consistent-sufficient sleep predicts improvements in self-regulatory performance and psychological strain. *Stress & Health, 2010*.

Barber, L. K., Munz, D. C., Bagsby, P. G. & Powell, E. D. (2010). Sleep consistency and sufficiency: are both necessary for less psychological strain? *Sleep and Health, 26*, 186-193.

Beehr, T. (2000). An organizational psychology meta-model of occupational stress. In C. L. Cooper (Ed.), *Theories of organizational stress*. Oxford: Oxford Publishing.

Benavides, F. G., J., B., Mira, M., Sáez, M. & Barceló, A. (2003). Occupational categories and sickness absence certified as attributable to common diseases. *European Journal of Public Health, 13*, 1-15.

Bjørnskau, T. & Longva, F. (2009). *Sikkerhetskultur i transport* (No. 1012/2009). Oslo: Institute of Transport Economics.

Bongers, P. M., de Winter, C. R., Kompier, M. A. J. & Hildebrandt, G. H. (1993). Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health, 19*, 297-312.

Brookhuis, K. A. & De Waard, D. (2000). Assessment of drivers' workload: performance and subjective and physiological indexes. In P. Hancock (Ed.), *Stress, workload and fatigue*. NY: CRC Press.

Broughton, J., Baughan, C., Pearce, L., Smith, L. & Buckle, G. (2003). *Work-related road accidents*: Transport Research Laboratory, UK.

Brown, I. D. (1994). Driver fatigue. *Human Factors, 36*(2), 298-314.

Bråten, M., Hovi, I. B., Jensen, R. S., Leiren, M. D. & Skollerud, K. H. (2013). *Arbeidsforhold i vegsektoren*. Oslo: FAFO.

Castaneda, A. E., Tuulio-Henriksson, A., Marttunen, M., Suvisaari, J. & Lönnqvist, J. (2008). A review on cognitive impairments in depressive and anxiety disorders with a focus on young adults. *Journal of Affective Disorders, 106*(1–2), 1-27.

Cunradi, C. B., Greiner, B. A., Ragland, D. R. & Fisher, J. M. (2003). Burnout and alcohol problems among urban transit operators in San Fransisco. *Addictive Behaviours, 28*, 91-109.

DaCoTa. (2010). Traffic Safety Fact Sheet - Heavy goods Vehicles and Buses.

Duffy, C. A. & McGoldrick, A. E. (1990). Stress and the bus driver in the UK transport industry. *Work and Stress, 1*, 17-27.

Duijts, S. F. A., Kant, I., Swaen, G. M. H., van den Brandt, P. A. & Zeegers, M. P. A. (2007). A meta-analysis of observational studies identifies predictors of sickness absence. *Journal of Clinical Epidemiology, 60*(11), 1105-1115.

Elvik, R., Høye, A., Vaa, T. & Sørensen, M. (2009). *The handbook of road safety measures*. Bingley: Emerald Publishing.

Erlam, A. R. (1982). Sickness absence in drivers of London taxis and buses. *Journal of Social Occupational Medicine, 32*, 20-25.

EU-OSHA. (2011).

Evans, G. W. (1994). Working on the hot seat: Urban bus operators. *Accident Analysis & Prevention, 26*(2), 181-193.

Evans, G. W. & Johansson, G. (1998). Urban bus driving: an international arena for the study of occupational health psychology. *Journal of Occupational Health Psychology, 3*, 99-108.

Fernández-Muñiz, B., Montes-Peón, J. M. & Vázquez-Ordás, C. J. (2007). Safety culture: Analysis of the causal relationships between its key dimensions. *Journal of Safety Research, 38*(6), 627-641.

Fernet, C., Austin, S. & Vallerand, R. J. (2012). The effects of work motivation on employee exhaustion and commitment: An extension of the JD-R model. *Work & Stress, 26*(3), 213-229.

Folkard, S. (1997). Black times: Temporal determinants of transport safety. *Accident Analysis & Prevention, 29*(4), 417-430.

Friswell, R. & Williamson, A. (2013). Comparison of the fatigue experiences of short haul light and long distance heavy vehicle drivers. *Safety Science, 57*(0), 203-213.

Fyhri, A. & Nævestad, T.-O. (2011). *Fornuftige følelser? En studie av utrygghet og oppfattet risiko blant sjåfører i Norge og Frankrike* (No. 1177/2011). Oslo: Institute of Transport Economics (TØI).

Greiner, B. A., Krause, N., Ragland, D. R. & Fisher, J. M. (1998). Objective stress factors, accidents, and absenteeism in transit operators: A theoretical framework and empirical evidence. . *Journal of Occupational Health Psychology, 3*, 130-146.

Griffin, M. A. & Neal, A. (2000). Perceptions of safety at work: a framework for linking safety climate to safety performance, knowledge and motivation. *Journal of Occupational Health Psychology, 5*(3), 347-358.

Gunzelmann, G., Gluck, K. A., Richard Moore Jr, L. & Dinges, D. F. (2012). Diminished access to declarative knowledge with sleep deprivation. *Cognitive Systems Research, 13*(1), 1-11.

Hackman, J. R., Oldham, G., Janson, R. & Purdy, K. (1975). A new strategy for job enrichment. *Motivating individuals in organisational settings*.

Halbesleben, J. R. B. & Buckley, M. R. (2004). Burnout in Organizational Life. *Journal of Management, 30*(6), 859-879.

Hitosugi M, G. S., Okubo T, Tokudome S. (2012). Sudden illness while driving a vehicle – a retrospective analysis of commercial drivers in Japan. *Scand J Work Environ Health, 38*(1), 84-87.

Holme, I., Helgeland, A., Hjermann, I., Leren, P. & Lund-Larsen, P. G. (1977). Coronary risk factors in various occupational groups: The Oslo study. *British Journal of Preventitive and Social Medicine, 31*, 96-100.

Hughes, J. & Bozionelos, N. (2007). Work-life balance as source of job dissatisfaction and withdrawal attitudes: An exploratory study on the views of male workers. *Personnel Review, 36*(1), 145-154.

Issever, H., Onen, L., Sabuncu, H. H. & Altunkaynak, O. (2002). Personality charactersitics, psychological symptoms, and anxiety levels of drivers in charge of urban transportation in Istanbul. *Occupational Medicine, 52*, 297-303.

Jovanovic, J., Batanjac, J. & Jovanovic, M. (1999). The influence of cardiovascular diseases of the drivers on the occurrence of traffic accidents. *Vojnosanitetski pregled, 56*(1), 3-8.

Karasek, R. A. & Theorell, T. (1990). *Healthy work: Stress, productiviety and the reconstruction of working life*. New York: Basic Books.

Kompier, M. A. J. (1996a). *Bus drivers: Occupational stress and stress prevention*: TNO Prevention and Health, Leiden. Department of Work and Organizational Psychology, University of Nijmegen.

Kompier, M. A. J. (1996b). *Bus drivers: occupational stress and stress prevention*. Geneva: TNO Prevention and Health, Leiden.

Kompier, M. A. J. & Di Martino, V. (1995). Review of bus drivers' occupational stress and stress prevention. *Stress & Health, 11*, 253-262.

Kotterba, S., Mueller, N., Leidag, M., Widdig, W., Rasche, K., Malin, J.-P., et al. (2004). Comparison of driving simulator performance and neuropsychological testing in Narcolepsy. *Clinical Neurology and Neurosurgery, 106*(4), 275-279.

Krause, N., Ragland, D. R., Greiner, B. A., Syme, S. L. & Fisher, J. M. (1997). Psychosocial job factors associated with back and neck pain in public transit operators. *Scand J Work Environ Health, 23*, 179-186.

Lazarus, R. S. & Folkman, S. (1984). *Stress, appraisal and coping*. New York: Springer Publishing Company.

Levi, L. (1998). Stress in organizations - theoretical and empirical approaches. In C. L. Cooper (Ed.), *Theories of organizational stress*. Oxford: Oxford University Press.

Li, G., Brady, J. E. & Chen, Q. (2013). Drug Use and Fatal Motor Vehicle Crashes: A Case-Control Study. *Accident Analysis & Prevention, http://dx.doi.org/10.1016/j.aap.2013.09.001*(0).

Longva, F. (2008). *"Anbud på norsk". Konkurranseutsetting og fristilling ved offentlig kjøp av persontransporttjenester: Effekter for tilbud, kostnader og arbeidstakere*. Oslo: Insititute of Transport Economics.

Mackie, R. R. & Miller, J. C. (1978). *Effects of hours of service regularity of schedules and cargo loading and truck driver fatigue* (No. No. HS-803 799): US Department of Transport Report.

Maslach, C. (2000). A multidimensional theory of burnout. In C. L. Cooper (Ed.), *Theories of organizational stress*. Oxford: OUP.

Maslach, C., Leiter, M. P. & Jackson, S. E. (2012). Making a significant difference with burnout interventions: Researcher and practitioner collaboration. *Journal of Organizational Behavior, 33*(2), 296-300.

Meijman, T. F. & Kompier, M. A. J. (1998). Bussy business: How urban drivers cope with time pressure, passengers and traffic safety. *Journal of Occupational Health Psychology, 3*(2), 109-.121.

Moe, D. (2006). *Bussjåførers opplevelser og vurderinger av sikkerhet, beredskap og arbeidsmiljø i bussbransjen*. Trondheim: SINTEF.

Mohamed, N., Mohd-Yusoff, M.-F., Othman, I., Zulkipli, Z.-H., Osman, M. R. & Voon, W. S. (2012). Fatigue-related crashes involving express buses in Malaysia: Will the proposed policy of banning the early-hour operation reduce fatigue-related crashes and benefit overall road safety? *Accident Analysis & Prevention, 45, Supplement*(0), 45-49.

Netterstrom, B. & Laursen, P. (1981). Incidence and prevalence of ischaemic heart disease among urban bus drivers in Copenhagen. *Scandinavian Journal of Social Medicine, 9*, 75-79.

Normark, D. & Juhlin, O. (2000). Bus driver talk - current practice and future communication support.

Nævestad, T.-O. (2008). Safety Cultural Preconditions for Organizational Learning in High-Risk Organizations. *Journal of Contingencies and Crisis Management, 16*(3), 154-163.

Parker, S. K. (2002). Designing jobs to enhance wellbeing and performance. In P. Warr (Ed.), *Psychology at work*. London: Penguin Books.

Parsons, M. (1986). Fits and Other Causes of Loss of Consciousness while Driving. *QJM, 58*(3-4), 295-303.

Phillips, R. O. & Sagberg, F. (2010). *Fatigue management in occupational driving. An assessment by literature review.* (No. 1081/2010). Oslo: Institute of Transport Economics.

Phillips, R. O. & Sagberg, F. (2013). Road accidents caused by sleepy drivers: Update of a Norwegian survey. *Accident Analysis & Prevention, 50*, 138-146.

Ragland, D. R., Winkleby, A. M., Schwalbe, J., Holman, B., Morse, L. & Syme, S. L. (1987). Prevalence of hypertension in bus drivers. *International Journal of Epidemiology, 16*, 208-214.

Schjøtt, J. (2002). Arbeidsmiljø og jobbtilpasning blant bussjåfører. *Tidsskrift for Den norske legeforening, 8-20 Mars*.

Sommese, T. & Patterson, J. C. (1995). Acute effects of cigarette smoking withdrawal: a review of the literature. . *Aviation Space and Environmental Medicine, 66*, 164-167.

STAMI. (2011). *NOA Faktabok om arbeidsmiljø og helse - status og utviklingstrekk*. Oslo: Statens arbeidsmiljøinstitutt.

Stork, A. D. M., van Haeften, T. W. & Veneman, T. F. (2006). Diabetes and Driving. Desired data, research methods and their pitfalls, current methods and future research. *Diabetes Research and Care, 29*(8), 1942-1943.

Taylor, A. H. & Dorn, L. (2005). Stress, fatigue, health and risk of road traffic accidents among professional drivers: the contribution of physical inactivity. *Annual review of public health, 27*(2).

TCRP. (2011). *Practices to protect bus operators from passenger assault*.

Tse, J. L. M., Flin, R. & Mearns, K. (2006). Bus driver well-being review: 50 years of research. *Transportation Research Part F: Traffic Psychology and Behaviour, 9*(2), 89-114.

van Dam, A., Keijsers, G. P. J., Eling, P. A. T. M. & Becker, E. S. (2011). Testing whether reduced cognitive performance in burnout can be reversed by a motivational intervention. *Work & Stress, 25*(3), 257-271.

Wagstaff, A. S. & Lie, J.-A. S. (2011). Shift and night work and long working hours -- a systematic review fo safety implications. *Scand J Work Environ Health, 37*(3), 173-185.

Williamson, A., Lombardi, D. A., Folkard, S., Stutts, J., Courtney, T. K. & Connor, J. L. (2011). The link between fatigue and safety. *Accident Analysis & Prevention, 43*(2), 498-515.

Winkleby, M. A., Ragland, D. R., Fisher, J. M. & Syme, S. L. (1988). Excess Risk of Sickness and Disease in Bus Drivers: A Review and Synthesis of Epidemiological Studies. *International Journal of Epidemiology, 17*, 255-262.

# Appendix 1 – Examples of shift rosters

The following rosters were obtained from bus companies in Norway for illustrative purposes only. They are not meant to be representative of all rosters worked in Norway.

## Company X

In Company X the rosters are computer-generated. It is not known which criteria are used to delimit the algorithm used, i.e. whether considerations are economical or whether they account for sleep model parameters, or whether the drivers get any say into the generation of the rosters.

It is clear from the Example 1, that the working hours vary a lot from week to week (see column on far right), in this case from 29 hours 26 minutes to over 45 hours in one week, but that on average each driver will work 35.5 or 37.5 h a week, unless they work part-time. In Example 1 we see mostly continuous early/day shift, with some split shifts, based on 37.5 h a week (see Avg./week).

The roster in Example 2 is made up almost entirely of split shifts, and there is also some weekend work. For example, on Monday of week 1, the driver will begin at 05:33 h and finish work 12 h later at 17:16 h, but he or she will only have worked 6 h 51 minutes during that time. This work will be in two periods, one beginning at 05:33 h and the other ending at 17:16 h.

Example 3 is based on a 35.5 h working week, but again there is a lot of week to week variation, with over 43 h worked in the first week of the roster. Here we see a mix of early, afternoon and split shifts, rotating both forward and backward after a day off.

Three other examples are provided for Company X (Examples 4 to 6).

Company X Example 1.

| | man | tir | ons | tor | fre | lør | søn | tid | tid |
|---|---|---|---|---|---|---|---|---|---|
| 15.1 | 134 6h20 6:14 17:24 | 134 6h20 6:14 17:24 | 148 8h34 7:08 16:12 | 148 8h34 7:08 16:12 | 148 8h34 7:08 16:12 | OFF | OFF | 38h22 | 38h22 |
| 15.2 | OFF | 151 8h23 7:12 16:05 | 151 8h23 7:12 16:05 | 134 6h20 6:14 17:24 | 134 6h20 6:14 17:24 | OFF | OFF | 29h26 | 29h26 |
| 15.3 | 132 6h30 6:08 16:52 | 132 6h30 6:08 16:52 | 132 6h30 6:08 16:52 | 151 8h23 7:12 16:05 | 151 8h23 7:12 16:05 | 111 8h52 7:02 18:24 | OFF | 45h06 | 45h06 |
| 15.4 | 131 6h53 6:07 16:32 | 131 6h53 6:07 16:32 | 148 8h34 7:08 16:12 | 148 8h34 7:08 16:12 | 131 6h53 6:07 16:32 | OFF | OFF | 37h47 | 37h47 |
| 15.5 | 131 6h53 6:07 16:32 | 131 6h53 6:07 16:32 | OFF | 134 6h20 6:14 17:24 | 134 6h20 6:14 17:24 | 111 8h52 7:02 18:24 | 103 7h06 6:02 13:08 | 42h24 | 42h24 |
| 15.6 | 151 8h23 7:12 16:05 | OFF | 151 8h23 7:12 16:05 | 143 7h15 6:54 14:39 | 143 7h15 6:54 14:39 | OFF | OFF | 31h16 | 31h16 |
| | | | | | | | Total: | 224h23 | 224h23 |
| | | | | | | | Average: | 224h23 | 224h23 |
| | | | | | | | Avg./Week: | 37h24 | 37h24 |

Company X Example 2

| Pos | man | tir | ons | tor | fre | lør | søn | ArbTid |
|---|---|---|---|---|---|---|---|---|
| 7.1 | 302 D 6h51 5:33 17:16 | 302 D 6h51 5:33 17:16 | OFF | 302 D 7h25 5:33 17:16 | 302 D 7h25 5:33 17:16 | 301 8h34 5:33 14:37 | 301 8h45 5:36 14:51 | 45h51 |
| 7.2 | 325 D 7h02 7:33 18:35 | OFF | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | 309 8h51 6:49 16:10 | OFF | 36h50 |
| 7.3 | 302 D 6h51 5:33 17:16 | 302 D 6h51 5:33 17:16 | 302 D 6h51 5:33 17:16 | 302 D 7h25 5:33 17:16 | 302 D 7h25 5:33 17:16 | OFF | OFF | 35h23 |
| 7.4 | 325 D 7h02 7:33 18:35 | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | OFF | OFF | 34h58 |
| 7.5 | 302 D 6h51 5:33 17:16 | 302 D 6h51 5:33 17:16 | 302 D 6h51 5:33 17:16 | 302 D 7h25 5:33 17:16 | 302 D 7h25 5:33 17:16 | OFF | OFF | 35h23 |
| 7.6 | 325 D 7h02 7:33 18:35 | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | 325 D 6h59 7:33 18:35 | OFF | OFF | 34h58 |
| | | | | | | | Total: | 223h23 |
| | | | | | | | Average: | 223h23 |
| | | | | | | | Avg./Week: | 37h14 |

## Company X Example 3

26/11/2011
10HØST

Roster: STRAUM Size: 24 Cycle: 1 3 Skift 19/10

| Pos | man | tir | ons | tor | fre | lør | søn | ArbTid |
|---|---|---|---|---|---|---|---|---|
| 24.1 | 304 7h15<br>5:36 13:21 | 312 6h05<br>6:05 12:40 | 304 7h15<br>5:36 13:21 | OFF | 335 6h56<br>12:14 19:10 | 315 7h41<br>12:10 19:51 | 309 8h16<br>12:32 21:18 | 43h28 |
| 24.2 | OFF | 314 6h53<br>6:33 18:10 | 303 7h01<br>5:35 17:34 | 314 6h53<br>6:33 18:10 | 335 6h56<br>12:14 19:10 | OFF | OFF | 27h43 |
| 24.3 | 342 8h31<br>16:04 24:35 | OFF | OFF | 332 7h54<br>11:06 19:11 | 319 6h45<br>7:00 14:10 | 303 8h27<br>5:40 14:07 | 308 8h07<br>12:06 20:43 | 39h44 |
| 24.4 | OFF | 309 6h43<br>5:56 12:39 | 319 6h45<br>7:00 14:10 | 320 6h31<br>7:06 13:37 | 332 7h54<br>11:06 19:11 | 307 7h53<br>6:28 14:51 | OFF | 35h46 |
| 24.5 | 312 6h05<br>6:05 12:40 | 315 7h00<br>6:35 17:40 | 320 6h31<br>7:06 13:37 | 319 6h45<br>7:00 14:10 | 321 2h35<br>7:09 8:34 | OFF | OFF | 28h56 |
| 24.6 | 311 8h17<br>6:04 14:21 | 307 6h57<br>5:39 17:09 | 318 7h11<br>6:59 18:34 | 712 8h08<br>16:47 24:55 | 710 6h04<br>13:37 19:41 | OFF | OFF | 36h37 |

| | |
|---|---|
| Total: | 212h14 |
| Average: | 212h14 |
| Avg./Week: | 35h22 |

Statistics by roster

| | |
|---|---|
| Total: | 5111h22 |
| Average: | 212h58 |

## Company X Example 4

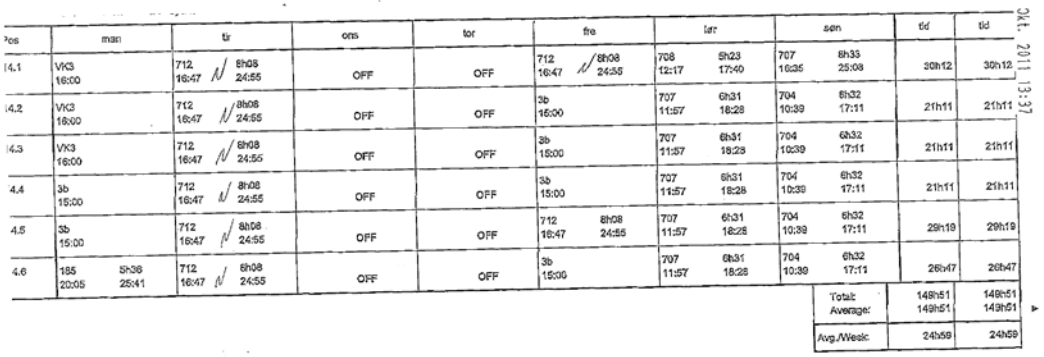
| is | man | tir | ons | tor | fre | lør | søn | tid | tid |
|---|---|---|---|---|---|---|---|---|---|
| | 141 7h07<br>6:49 18:39 | 133 7h25<br>6:11 17:41 | OFF | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 106 8h09<br>6:10 14:49 | 102 8h47<br>5:54 15:11 | 46h18 | 46h18 |
| | OFF | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | OFF | OFF | 29h40 | 29h40 |
| | 192 3h00<br>5:30 8:30 | 107 4h50<br>6:34 10:24 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 109 8h41<br>6:28 15:39 | OFF | 38h46 | 38h46 |
| | 108 7h13<br>5:35 17:04 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | OFF | OFF | 36h53 | 36h53 |
| | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 120 6h35<br>5:54 12:59 | 133 7h25<br>6:11 17:41 | OFF | OFF | 36h15 | 36h15 |
| | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | 133 7h25<br>6:11 17:41 | OFF | OFF | 37h05 | 37h05 |
| | | | | | | | Total: | 224h57 | 224h57 |
| | | | | | | | Average: | 224h57 | 224h57 |
| | | | | | | | Avg./Week: | 37h30 | 37h30 |

Okt. 2011 13:30

Nr. 0021 S. 2

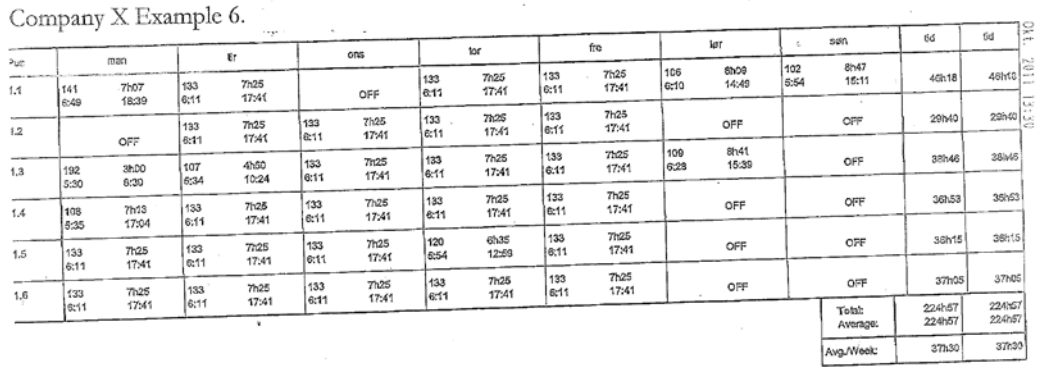
side 309

## Company X Example 5



| Pos | man | tir | ons | tor | fre | lør | søn | tid | tid |
|---|---|---|---|---|---|---|---|---|---|
| 4.1 | VK3 16:00 | 712 16:47 // 8h08 24:55 | OFF | OFF | 712 16:47 // 8h08 24:55 | 708 12:17 / 8h23 17:40 | 707 16:35 / 8h33 25:08 | 30h12 | 30h12 |
| 4.2 | VK3 16:00 | 712 16:47 // 8h08 24:55 | OFF | OFF | 3b 15:00 | 707 11:57 / 6h31 18:28 | 704 10:39 / 6h32 17:11 | 21h11 | 21h11 |
| 4.3 | VK3 16:00 | 712 16:47 // 8h08 24:55 | OFF | OFF | 3b 15:00 | 707 11:57 / 6h31 18:28 | 704 10:39 / 6h32 17:11 | 21h11 | 21h11 |
| 4.4 | 3b 15:00 | 712 16:47 // 8h08 24:55 | OFF | OFF | 3b 15:00 | 707 11:57 / 6h31 18:28 | 704 10:39 / 6h32 17:11 | 21h11 | 21h11 |
| 4.5 | 3b 15:00 | 712 16:47 // 8h08 24:55 | OFF | OFF | 712 16:47 // 8h08 24:55 | 707 11:57 / 6h31 18:28 | 704 10:39 / 6h32 17:11 | 29h19 | 29h19 |
| 4.6 | 185 20:05 / 5h36 25:41 | 712 16:47 // 8h08 24:55 | OFF | OFF | 3b 15:00 | 707 11:57 / 6h31 18:28 | 704 10:39 / 6h32 17:11 | 26h47 | 26h47 |
| | | | | | | | Total: | 149h51 | 149h51 |
| | | | | | | | Average: | 149h51 | 149h51 |
| | | | | | | | Avg./Week: | 24h59 | 24h59 |

## Company X Example 6.



| Pos | man | tir | ons | tor | fre | lør | søn | tid | tid |
|---|---|---|---|---|---|---|---|---|---|
| 1.1 | 141 6:49 / 7h07 18:39 | 133 6:11 / 7h25 17:41 | OFF | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 106 6:10 / 8h09 14:49 | 102 5:54 / 8h47 15:11 | 46h18 | 46h18 |
| 1.2 | OFF | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | OFF | OFF | 29h40 | 29h40 |
| 1.3 | 192 5:30 / 9h00 8:30 | 107 6:34 / 4h50 10:24 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 109 6:28 / 8h41 15:39 | OFF | 38h46 | 38h46 |
| 1.4 | 108 5:35 / 7h13 17:04 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | OFF | OFF | 36h53 | 36h53 |
| 1.5 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 120 5:54 / 6h35 12:59 | 133 6:11 / 7h25 17:41 | OFF | OFF | 38h15 | 38h15 |
| 1.6 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | 133 6:11 / 7h25 17:41 | OFF | OFF | 37h05 | 37h05 |
| | | | | | | | Total: | 224h57 | 224h57 |
| | | | | | | | Average: | 224h57 | 224h57 |
| | | | | | | | Avg./Week: | 37h30 | 37h30 |

## Company Y

Company Y has a set 2 week roster for all drivers, in which they work one week on (Thursday to Wednesdsay) and one week off (Thursday to Wednesday). The roster is based around split shifts, and is shown in Table A1.

*Table A1. Roster for Company X*

| Week | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 1 | Off | Off | Off | 06:30-12:00 | 06:30-12:00 | Off | 15:00-19:30 |
| | | | | 14:30-19:00- | 15:00-19:30- | | |
| 2 | 06:30-12:00 | 06:30-12:00 | 06:30-12:00 | Off | Off | Off | Off |
| | 14:30-19:00- | 14:30-19:00- | 14:30-19:00- | | | | |

# Appendix 2 – Sleep, self-regulation, burnout and safety performance

## Self-regulation and safety performance

The role of reduced ability to self-regulate in the effects of sleep debt is being seen as increasingly important, and is especially likely to play a role in the safety performance of those who work irregular shifts (L. K. Barber et al., 2010). Self-regulation is required to monitor and control thoughts, emotions and behaviour (Muravan & Baumeister, 2000). There is scientific precedent for this: glucose depletion leads to lower self-regulatory performance, and lack of sleep leads to lowered glucose levels. In short, lack of sleep leads one with less self-regulatory energy for managing stressors and increased emotional reactivity to stressful events. This is the resource-replenishment approach. An idea has also recently put forward to explain why recovery from sleep loss following compensatory sleep (i.e. sleep to compensate for acute bouts of sleep loss) often fails to result in complete recovery. The idea is that sleep is more beneficial when acquired through consistent and compensatory, rather than just compensatory, habits. This is because consistency is a form of exercised self-regulation, which leads to resource enhancement (as opposed to just replenishment following acute bouts of sleep loss). Indeed, there is evidence to suggest that consistent sleep duration is just as important at predicting self-regulatory functioning as total sleep duration. Thus it is possible that schedules leading to inconsistent sleep times and durations, may deplete self-regulation via two mechanisms: psychological strain and observed inability to regulate oneself, where the irregular nature of shift work may increase perceptions of poor self-regulation. Whatever the mechanism involved, lack of self-regulation leads to poor health behaviours, often by decreasing the individual's ability to resist non-adaptive ways of coping with stress, which has implications for both health (e.g. poor eating habits, smoking or alcohol use) and job or safety performance (e.g. lack of ability to control distracting thoughts while driving).

There is good reason to believe that self-regulation is important for stressor-induced health and sleep outcomes in bus drivers. Several undesirable health behaviours are well documented for bus drivers, and a positive relationship has been found between years spent driving a bus and alcohol consumption, and between alcohol consumption and strain reactions (Ragland et al., 1987). There is less evidence, however, that reduced self-regulation results in poorer safety performance. Notably, however, the health behaviours linked to poor health outcomes also often affect safety performance. In particular, alcohol or nicotine abstinence (drivers are not allowed to drink or smoke on the job) have both been associated with reduced driver performance (Sommese & Patterson, 1995), and may also over the longer term affect performance through eliciting undesirable health outcomes such as fatigue.

## Sleep, burnout and safety performance

When sleep debt is sustained over the course of months or years, the effects of mental fatigue and poor self-regulation on health are serious. Poor health behaviours due to poor self-regulation become ingrained, and sustained mental fatigue leaves one perilously exposed to the effects that chronic stress has on health, often leading to coronary, psychological and associated musculoskeletal problems.

A model which has been influential with regards to the long-term effects high work stress and restricted sleep in recent times is burnout (Maslach, 2000; Maslach, Leiter & Jackson, 2012). Burnout theory places a lot of emphasis on the effect of chronic interpersonal work stressors. Burnout is conceptualized as lying on the extreme of a spectrum of energy for work. At the opposite end of the spectrum is job engagement. According to newer models of burnout there are six areas or dimensions where job-person fit is important: workload, control, reward, community, fairness and values. If fit between the characteristics of the person and nature of the job are good in each area the result is engagement. If fit is poor in many or all areas, the result is burnout. Burnout is identified by the three dimensions of emotional exhaustion; cynicism and detachment from the job; and a sense of inefficacy and failure.

The three-dimensional structure of burnout has now been identified in many occupational samples and across many lands using the Maslach Burnout Inventory (MBI) (Maslach et al., 2012). The "cynicism and detachment" dimension of burnout may be particularly pernicious in terms of driver safety, because it implies that as a result of burnout, drivers will stay on, but only do the bare minimum, with serious implications for job and safety performance. Indeed, measures of burnout have been found to correlate well with alcohol dependence in bus drivers, something which not only indicates cynicism and detachment, but also that burnout may combine with reduced self-regulation (Cunradi et al., 2003). For this and other reasons, burnout theory, which is being increasingly supported by evidence, also leads us to believe that poor health due to stress and sleep can result in poor safety performance at work.

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