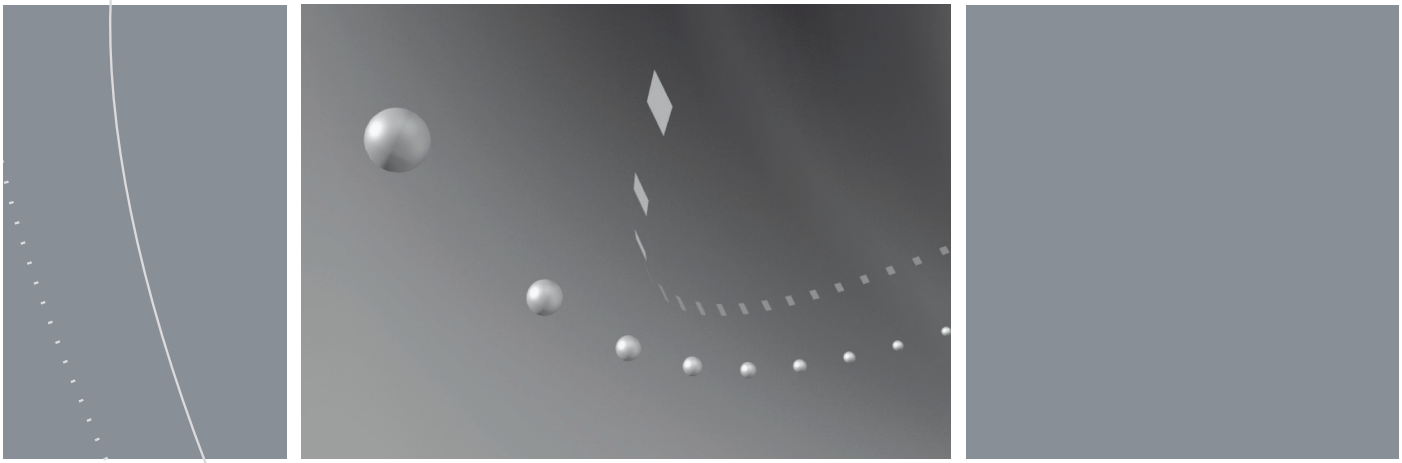
VTI notat 32A–2012
Published 2012

www.vti.se/publikationer



Why does a sleepy driver continue to drive?

Joel Johansson

vti
FINDING A BETTER WAY

Preface

This study is a master thesis done at the Department of computer and information science at Linköping University (LIU-IDA/KOGVET-A--12/008—SE) in collaboration with VTI.

First and foremost I would like to thank the Swedish National Road and Transport Research Institute (VTI) and specifically my supervisor Anna Anund for her unquestionable expertise and support during the work with this thesis. Working with Anna has been truly inspiring.

I would also like to thank my dear friends Sally Ståhl and Anders Mannerhagen for all the helpful discussions and input regarding the work with this thesis. To have Sally and Anders to talk and discuss with, to help get my mind off the thesis has been very valuable to me.

Last but not least, I would like to thank my family for their constant love and support throughout my education. Without them I literally would not have succeeded with this undertaking, and I will always be extremely grateful for their support.

Linköping, August 2012

Joel Johansson

Quality review

Internal peer review was performed on 20 June 2012 by supervisor Anna Anund. Joel Johansson has made alterations to the final manuscript of the report. The research director of the project manager Jan Andersson examined and approved the report for publication on 13 August 2012.

Kvalitetsgranskning

Intern granskning har genomförts 20 juni 2012 av handledare Anna Anund. Joel Johansson har genomfört justeringar av slutligt rapportmanus. Projektledarens närmaste chef, Jan Andersson, har därefter granskat och godkänt publikationen för publicering 13 augusti 2012.

Contents

Why does a sleepy driver continue to drive?

by Joel Johansson
VTI (Swedish National Road and Transport Research Institute)
SE-581 95 Linköping, Sweden

Summary

In the traffic domain it is commonly known that sleepiness is a highly contributing factor in traffic accidents. Research has shown that sleepiness among drivers is present in about 16–23 per cent of all car accidents. In the aviation and railway industry a method or framework with some shared influences from the Human Factors approach, called Fatigue Risk Management (FRM) has been used to investigate how social and organisational factors affect the personnel's level of sleepiness. The overall aims of this study are to investigate how truck drivers' experience, fight and counteract sleepiness in their daily work environment. The results show that drivers face a wide variety of sleep contributing factors, stemming from both organisational factors and individual behaviour. Possible ways of counteracting truck driver sleepiness, concerning both the individual and the organisation, are also suggested.

Varför fortsätter en sömnig förare att köra?

av Joel Johansson
VTI
581 95 Linköping

Sammanfattning

Inom trafikforskningen är det allmänt känt att sömnighet är en starkt bidragande faktor vid trafikolyckor. Tidigare forskning har visat att sömnighet hos förare är närvarande i 16–23 procent av alla bilolyckor. Inom flyg- och järnvägsdomänen har en metod, med en stark influens från human factors-området, kallad Fatigue risk management (FRM) använts för att undersöka hur sociala och organisatoriska faktorer påverkar personalens sömnighetsnivå. Dock har denna metod inte använts för att undersöka lastbilsförares sömnighetsnivå i någon större utsträckning. Studiens syfte var att undersöka hur lastbilsförare upplever, motarbetar och motverkar sömnighet i deras dagliga arbetssituation. Resultaten visar att lastbilsförare i sitt arbete möter en stor mängd trötthetsbidragande faktorer, som kan härledas både till organisatoriska faktorer och individuellt beteende. Möjliga sätt att motverka sömnighet bland lastbilsförare, riktade mot både individen och organisationen, föreslås.

1 Introduction

In the traffic domain it is commonly known that driver sleepiness is a highly contributing factor in traffic accidents. Research has shown that sleepiness among drivers is present in about 16–23 % of all car accidents (Horne & Reyner, 1995). Even with figures as strong as these, there is still reason to believe that the estimated number of unknown sleepiness related crashes is even larger. There is still a need to find ways to determine both crashes where sleepiness is a contributing factor and the prevalence of sleepy driving.

The Swedish road safety programme "Vision Zero" aims to eliminate casualties on Swedish roads, thus passively include finding a solution to the problems with fatigued drivers. Sleepy drivers do not only constitute a risk for themselves, they also constitute a grand risk for fellow drivers on the roads. One major part of the problem is that drivers think of themselves as able to predict the imminent sleep onset, which is a false belief (Anund, 2010).

A consensus meeting in 2000 involving world leading fatigue and sleepiness researchers concluded that information and education aimed at the public and transfer companies is one of the most important countermeasures against driver fatigue and sleepiness (Åkerstedt & Haraldsson, 2001). To raise the awareness of driver sleepiness and also to help drivers choose the appropriate countermeasures, Länsförsäkringar (a Swedish insurance company) have distributed information both in paper form and on the internet. The effect of this type of initiative is unfortunately seldom evaluated.

If one explores the research regarding fatigued drivers and factors contributing to driver fatigue, several factors seem to re-occur time after time. Among these are irregular shift work, driving by night or early morning, so called *time of day effect* (Sallinen & Kecklund, 2010), monotonous road environment (Thiffault & Bergeron, 2003), and long working/driving hours, also known as the *time on task effect*.

One group of drivers that often face many of these factors in their daily work are the truck drivers working in commercial transport. When researching the literature one finds very little detailed information about the truck drivers working situation and their mentality towards the issues regarding sleepiness and sleepiness-contributing factors, even though certain groups of truck drivers perform their duties in the presence of these sleepiness-contributing factors every day.

Even though researchers in the field agree that the issue of driver sleepiness is a serious problem that needs to be taken care of, Sweden is far behind other nations in the work for a more precautionary strategy for handling driver sleepiness among professionals working in commercial transportation. While sleepiness in recent years have been recognised as a major problem among cabin personnel in the aviation and railway industry, less effort has been done in order to explore the impact of fatigue and sleepiness in commercial transportation.

In the aviation and railway industry a method or framework with some shared influences from the *Human Factors* approach, called *Fatigue Risk Management (FRM)* has been used to investigate how social and organisational factors affect the personnel's level of fatigue. From the FRM point of view other, more latent factors in relation to truck drivers' working situation are evaluated in the purpose of hopefully exploring how something, not directly present in the working situation, possibly may have an impact on a driver's sleepiness level.

1.1 Definitions and Clarifications

This study has been performed on behalf of the Swedish National Road and Transport Research Institute (VTI).

Throughout the rest of this report, the terms “sleepiness” and “fatigue” are used to describe the need for sleep while recognising that the two terms have more precise definitions in other contexts (Shen, et al., 2006). The general theme to this terminology is that “fatigue” in this study is used as the broader term and “sleepiness” is used to refer to the most dangerous levels of fatigue that is closest to actual sleep.

1.2 Sleep

Sleep is a physiological structural process of the central nervous system and immune system. Sleep is simply thought of as a recovery process from fatigue and sleepiness (Dawson & McCulloch, 2005).

Sleep and recovery acts through a series of cycles, where the sleep intensity moves from light sleep (level 1-2) to deep sleep (level 3-4, non-Rapid Eye Movement (NREM)-state) and back to dream sleep (the blackened Rapid Eye Movement (REM)-state). A person experience 4-6 of these cycles during a normal night’s sleep, with a decreasing rate of sleep recovery during the sleeping period as the NREM periods ceases (Åkerstedt and Kecklund, 2000; Borebély and Achermann, 1999), see Figure 1.

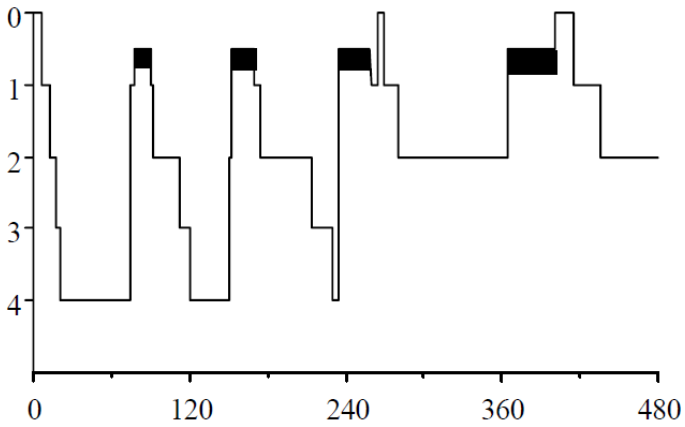


Figure 1 Diagram showing the sleep cycles during a normal night’s sleep (Åkerstedt & Kecklund, 2000).

The need for sleep is a question debated among researchers where Ferrara and De Gennaro (2001) writes that sleep is very individual but that “*a scientifically based controversy does exist*” regarding the average daily sleep quota. Ferrara and De Gennaro describes how different studies suggest 9-10 hours of sleep as well as others that conclude that humans easily can adapt to a 5-6 hour sleep schedule. Likewise writes Åkerstedt and Kecklund (2000) that sleep in an average human need to be about 7.2 h (± 1,5h), but is flexible as lost sleep is quickly regained through more deep sleep, a phenomena also described by Borebély and Achermann (1999).

1.2.1 Circadian Rhythm

The circadian rhythm is the body’s own system for regulating wakefulness and sleep, also referred to as the ‘biological clock’. This system has greater impact on our lives than just compelling us to sleep and to wake up. It also has great effect on our hourly

waking behaviour, as reflected in fatigue, alertness and performance (Van Dongen & Dinges, 2000).

The circadian rhythm may be masked through factors such as stress, food intake, lighting conditions or drug intake (e.g. caffeine). The masking phenomena goes two ways, it can create the appearance of a circadian rhythm as well as obscure it (Van Dongen & Dinges, 2000). Many studies mention the circadian effect as more prominent during the afternoon, often mentioned as the "afternoon dip" (among others: Horne, 2010; Van Dongen and Dinges, 2000; Horne and Reyner, 1995). As the accident risk is highest during night hours (02-06) and with a second peak during the afternoon (14-16), the circadian rhythm is often mentioned as a likely contributing factor to these increases in accident risk (Thiffault & Bergeron, 2003).

The circadian rhythm is an omnipresent factor that combined with other fatigue contributing factors makes a situation more dangerous. This will be discussed further in the *Shift Work*-section.

1.2.2 Sleep Homeostasis

According to Borybély and Achermann (1999), sleep homeostasis refer to the sleep-wake dependent aspect of sleep regulation. This refers to a process that enhance sleep propensity when sleep is absent or reduce sleep propensity in response to excessive sleep. This process consists of three sub processes; a homeostatic process determined by sleep and waking, the circadian rhythm and the alternation between NREM- and REM states in sleep.

These factors combined create one of the most important fatigue and sleepiness contributing factors. After a night of poor sleep, one is more likely to feel sleepy since these mentioned processes fight to keep balance between one's sleep need and one's acquired sleep.

The common denominator in many definitions of sleepiness is that sleepiness occurs because of an activity that has been going on too long, and that the activity in question reflects the total working time of the brain (Åkerstedt & Kecklund, 2000). In a similar way Dawson and McCulloch (2005) describe some seemingly obvious facts in relation to fatigue in the workplace, when they write that:

> *"The fatigue 'clock' starts 'ticking' from the moment of wake and continues 'ticking' until the next sleep period. It does not, as often implied in prescriptive regulatory systems, start ticking that an individual starts work. As a consequence, the point at which fatigue is likely to become a problem is more directly related to the duration of wakefulness and only indirectly to the length of the work period. … Second, sleep is a 'recovery process' for wake. That is, during sleep we recover from fatigue and, as a corollary, sleep enables us to 'buy' a certain amount of subsequent wakefulness above a given threshold. This implies a linear relationship between sleep and alertness; that alertness increases as a function of prior sleep". (Dawson & McCulloch, 2005, p. 376)*

An individual's own fatigue- or sleepiness level seems to depend more on the received amount of sleep and total time being awake, rather than the time spent on performing a specific task. This becomes relevant when examining existing work schedules and shift work periods, but also in relation to an organisational view of a specific work situation.

1.3 Fatigue and sleepiness

Sleepiness is a state that almost all people experience once or more every 24 hours. One might think that the sleepiness phenomenon, common across all of humanity, is well described and defined. This is however not always the case. Often the definitions of sleepiness are operational, aimed to be more a specific tool for assessment of an otherwise heterogeneous phenomenon (Shen, et al., 2006).

Åkerstedt and Kecklund (2000) recognise that sleepiness is an ambiguous term that can bear different meanings between both individuals and disciplines. Even if the meaning of the term somewhat differ, the authors describes one common theme; that all reviewed definitions of the term "sleepiness" describes some level of being unable to continue an on-going activity, often because the activity has gone on for "too long". The activity described here is the brain's total time of work in a waking individual (Åkerstedt & Kecklund, 2000). Åkerstedt and Kecklund further describe how sleepiness affects our behavior in four following levels:

1. *Fully awake.*
2. *Reasonable sleepiness, when the central nervous system maintains an adequate level of behaviour, but functions slower than usual.*
3. *Severe sleepiness, when the individual repeatedly is overcome by fatigue and disruptions in the interaction with the environment occurs. The performance gets erratic and irregular. These symptoms also characterise patients with narcolepsy, but also individuals that are fatigued although they are healthy. This phenomenon was first described by Bills (1931) who introduced the term "lapses".*
4. *Sleep, when interaction with the surrounding environment no longer occurs. One special form is "drowsiness" when the individual hasn't yet recovered from a recently finished sleep.* Åkerstedt and Kecklund, 2000, p. 9, (author's own translation)

Since definitions of fatigue and sleepiness are most often operational, Thiffault and Bergeron (2003) define fatigue in their study as "… *a general psychophysiological state which diminishes the ability of the individual to perform the driving task by altering alertness and vigilance"*. While Gander et al (2011) defines fatigue as "*the inability to function at the desired level due to incomplete recovery from the demands of prior work and other waking activities"*. Dinges (1987), as cited in Åkerstedt and Kecklund (2000), defines sleepiness as *"… the lack of ability to maintain awake levels of vigilance without assistance from the environment/situation*".

However, in this study the following definition of sleepiness will be used; "*By 'sleepy' or 'sleepiness' we refer to situations when you as a driver have to make efforts to stay awake while driving"* (Anund et al. (2004); Anund et al. (2008)). This definition was chosen as it is simple to relate to as well as it translates to the highest value on the Karolinska Sleepiness Scale, thus referring to a level of severe sleepiness (Horne & Burley, 2010).

1.4 Fatigue and sleepiness in the traffic domain

It is commonly known that driver sleepiness is a highly contributing factor in traffic accidents. Horne and Reyner (1995) examined traffic accidents in southwest England and the midlands, using police records and on the spot interviews. A number of criteria were used to map an accident as sleep related. Among these criteria were for example alcohol levels below the legal driving limit, no signs of breaks applied beforehand (no skid marks), no mechanical defects on the vehicle and the accidents collected also occurred in good weather conditions with clear visibility. The results showed that 16-23 % of the accidents were related to sleep, with the higher number relating to accidents on highways. The results show that a large proportion of traffic accidents were sleep related, but there is reason to believe that the figures could be even higher, due to the strict criteria used to map the incidents.

The driver's seldom confess to have been sleepy whilst driving and there are no statistics of accidents where sleepiness possibly could have been a contributing factor (Linderholm, et al., 2008). This makes it difficult when estimating the proportion of accidents caused by driver sleepiness. Åkerstedt and Kecklund (2000) also mentions that the forms used by Swedish police to describe accidents do not display sleepiness as a possible accident cause, which means that no correct statistics regarding driver sleepiness in traffic accidents are available.

1.4.1 Disturbed sleep

One of the most obvious sleepiness contributing factors is disturbed night sleep. A number of different factors are known to disturb sleep. Among the main disturbing factors mentioned in the literature are stress, noise and sickness. In order to reduce sleep disturbances one should control the caffeine intake prior sleep and also keep a darkened sleeping area, a cool temperature in the room (16-18 degrees Celsius) combined with regular sleeping times (Åkerstedt & Kecklund, 2000).

In relation to sleep disturbing factors, it might be interesting to briefly describe some of the effects regarding sleep deprivation and superfluous sleep. Horne (2010) offers a review of a large variety of sleep studies of somewhat abnormal sleeping behaviour. For example, Mullaney et al. (1977) (as cited in Horne 2010) let eight subjects reduce their daily sleep by half an hour every two to four weeks until they couldn't go on (about 5 h). The results from the study showed that eight months after the study finished, even though the subjects were free to sleep as much as they wished, six of the subjects continued to average about 1 - 2.5 hours below their original baseline levels while their daytime effectiveness and other effects on behaviour seemed to be quite normal. Sleep EEG showed that their lost sleep was mostly at the expense of stage 2 and REM-sleep, with an increase in stage 4-sleep along with a missing last sleep cycle. Horne (2010) further writes that there is little or no evidence to show that 6.5 h sleep on a habitual basis is harmful, unless it causes excessive daytime sleepiness.

In another study by Czeisler et al. (1980), also cited in Horne (2010), subjects stayed a month in a time free, closed environment while monitoring the sleeping time of the subjects. The results showed that average sleeping time after the subjects disengaged from the circadian rhythm was about 11h (ranging from 7.8 to 14.4h). The arguments for this prolonged sleep time was that there was no biological need for longer sleep, more than serving as a "time-filler".

1.4.2 Shift Work

The term shift work refers to a wide range of work hour arrangements involving two or more teams (shifts) that differ in the starting and finishing times of their work (Sallinen & Kecklund, 2010).

When one thinks about shift work, one assumes that there are many factors that might have an impact on an individual's experienced fatigue and sleepiness. Sallinen and Kecklund (2010) reviewed different studies on different aspects of shift work, such as shift length, shift rotation etc. Their main finding from the reviewed observational studies was that night-, early morning shifts along with quick changes (less than 8h between different working shifts) and extended shifts (>16 h) are associated with short sleep and an increase in sleepiness. Sallinen and Kecklund concluded that at the moment, it is easier to say what features *not* to include in shift work scheduling, without having completely solid recommendations to improve the shift work climate regarding fatigue and sleepiness, mainly due to difficulties in isolating the effects of an individual change to shift work arrangements in the reviewed studies.

Åkerstedt (2003) describes problems of sleep disturbances surrounding shift work, as shift workers for example often report higher frequencies of disturbed sleep. Åkerstedt also concludes that irregular working hours seem to have an acute impact on sleep and alertness in relation to night and morning shifts. This effect also seems to affect time off.

Circadian rhythm influence performance and alertness in shift workers in a negative way (Åkerstedt, 2003; Sallinen and Kecklund, 2010). Humans have the ability to shift their circadian rhythm to some extent, which may result in certain acclimatisation for example in working night shifts. Åkerstedt (2003) writes that this acclimatisation is dependent on a variety of factors, such as light exposure, but under optimal conditions this shift will occur at a speed of ~1 hour per day. This shift in circadian rhythm is however counteracted by a light pattern in opposition during work hours.

1.4.3 Monotony

Thiffault and Bergeron (2003) gives a detailed introduction to the concept of monotony. Based on the habituation process, low variation can lead to a decrease in arousal, which induces driver fatigue. The authors describe the different between *exogenous* and *endogenous* factors influencing fatigue, where the exogenous factors stems from the individuals interaction with the road environment and the endogenous instead emanate from within the individual, caused by known fatigue related factors as circadian rhythm, time-of-task effects along with sleep-related problems (Thiffault & Bergeron, 2003).

In their study Thiffault and Bergeron examined the impact of the monotony by testing a fairly large sample of test participants in a driving simulator, examining the effects of monotony in relation to variables as time on task and road environment. They found significant monotonous effects of time on task and clear indications of monotonous effects in the road environment setting, although these results were not significant.

1.4.4 Truck Drivers

Truck drivers are a group of professionals that face several of the sleepiness contributing factors mentioned in previous sections. According to May (2011), truck

drivers are at risk because of the long distances, long and irregular work shifts and high demands to get to the destinations in time. May further writes that truck drivers are at a higher risk of crashes because of their high amount of miles driven.

Kecklund and Åkerstedt (1993) and Mitler et al. (1997), documented the truck drivers sleepiness levels during work. Mitler et al. measured sleepiness in 80 truck drivers through EEG and eye movements. The results showed that the drivers slept for an average of 4.78 hours, about two hours less than their reported ideal sleep as well as two drivers that experienced stage 1 sleep while driving. 45 out of 80 drivers were judged to be drowsy in at least one segment, but 1067 out of the 1989 segments showing drowsy drivers involved just eight drivers.

The most common approach for overall risk management in road transport today (at least in Sweden) is a traditional view focusing on hours of service (HoS) with regulations regarding the maximum allowed time at work, time when driving and minimum allowed time to rest at. These regulations have some advantages one of them is that they are straightforward to interpret and that they are simple to enforce. On the negative side, the HoS-regulations do not take account of the circadian rhythm, nor do they address the duty cycle (and therefore not accumulated sleep debt) and it usually do not include non-work-related time such as commuting (Gander, et al., 2011).

The three main purposes of the HoS in Sweden are: 1) To ensure a sound competition between the actors in the road transport sector 2) Give the drivers a good social situation, and 3) Contribute to traffic safety. (Transportstyrelsen, 2011)

To rest is further described as "*a sustained period of time that the driver can dispose freely*". The general features of the Swedish HoS are summarised below:

Driving:

> Total driving time for a day is 9 h, which may be stretched to 10 h two times a week. A driver is allowed to have an aggregated driving time of 4 hours and 30 minutes before having to take a break of at least 45 minutes. This break can be split into two parts of 15 and 30 minutes, where the longer break must be taken last. When 45 minutes of rest time is registered in the tachograph, another driving period of 4 hours and 30 minutes starts again. Maximum amount of allowed driving time during one week is 56 h and during two weeks the maximum amount of driving time is 90 h.

Daily and Weekly Rest:

> 24 h after finishing a daily or weekly rest a driver shall have had another legal daily rest. A daily rest is either normal or reduced. A normal daily rest shall is at least 11 consecutive hours. This daily rest can be split into two periods consisting of one 3 h period (can be taken whenever during the shift) and another 9 h period of consecutive rest. The sum of this parted daily rest shall be at least 12 h and drivers are allowed a maximum of three reduced daily rests between two weekly rests.
>
> A weekly rest is at least 45 h of consecutive rest. Weekly rest can be reduced to 24 h, but this reduction in rest shall be compensated within 4 weeks.

Some examples of legal variations of the Swedish HoS are described in Figure 2.

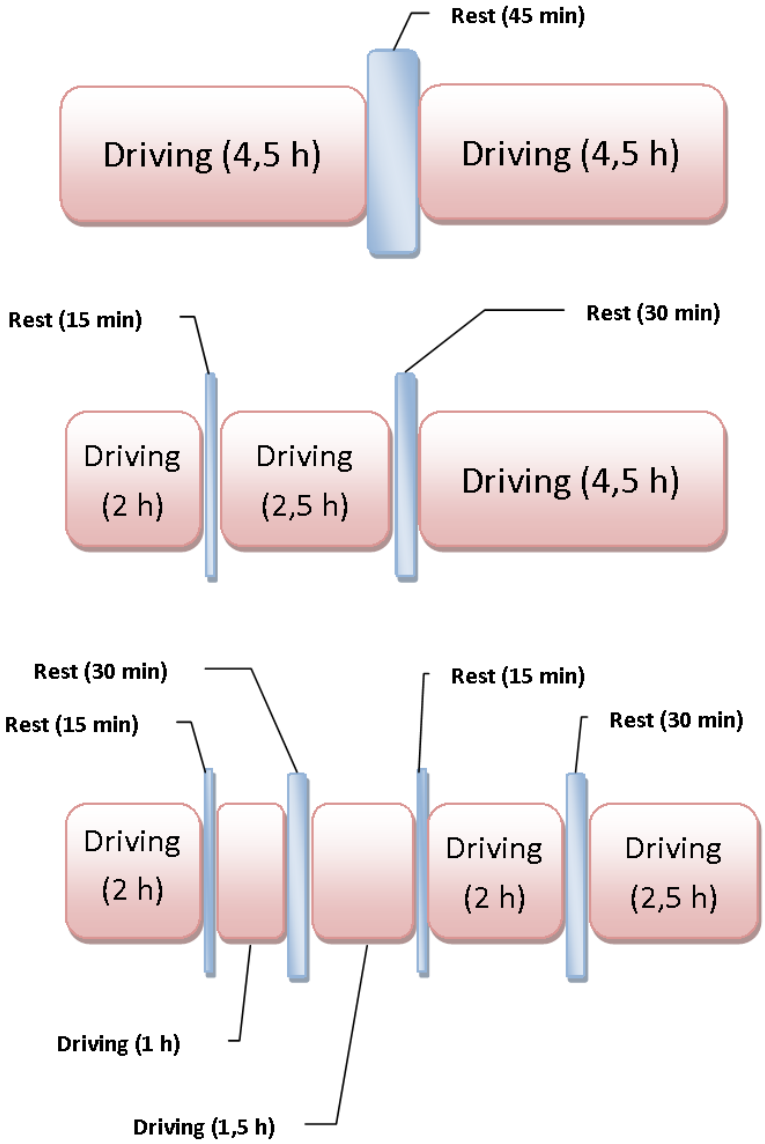


Figure 2 Legal distributions of Drive and rest times. Adapted from Transportstyrelsen (2011).

The truck drivers record their *drive* time, *rest* time and *other work* through a tachograph. The truck drivers themselves have a responsibility to set the tachograph in either *rest*- or *other work*-mode. *Other work* translates to work performed when the truck stands still, for example load and unload of cargo. *Drive* time is automatically recorded when the truck moves.

If a truck driver does not have the right recorded amount of rest in relation to drive time during an investigation by Swedish police, they and their company may be fined.

1.5 Measuring fatigue and sleepiness

Several types of tests, scales and monitoring methods are used in fatigue and sleepiness research. This section aims to give a brief introduction to the most frequently used tests

and also some of the differences between the subjective and objective tests and monitoring methods.

1.5.1 Subjective and Self-Reported Measures

A number of self-reported measures are used in fatigue and sleepiness research. Self-reported measures hold some advantages compared to the objective measurements regarding the testing procedure. For example, subjective sleepiness scales are quickly completed, about one minute of the participant sitting down compared to the ten minute procedure of a simple reaction time (RT) test, for example the Psychomotor Vigilance Test (PVT) (Horne & Burley, 2010). Secondly, objective tests are often administered in quiet, non-distracting and relaxing settings, unlike the subjective measures that are often undertaken just after the participant has sat down, often in a group setting.

Among the most frequently used subjective scales in sleepiness research is the Karolinska Sleepiness Scale (KSS). The KSS (Åkerstedt & Gillberg, 1990) uses a scale from 1-9 where each number represent a verbal statement regarding the subjects own level of sleepiness. Usually the subject reports his or her sleepiness level in short intervals, which can be as short as once every five minutes. The KSS levels, as they are described by Horne and Burley (2010) are presented below:

1. Extremely alert
2. Very alert
3. Alert
4. Rather alert
5. Neither alert nor sleepy
6. Some signs of sleepiness
7. Sleepy, no effort to stay awake
8. Sleepy, some effort to stay awake
9. Very sleepy, great effort to keep awake, fighting sleep

One advantage of this scale compared to reaction time tests is that these verbal definitions give the apparent level of sleepiness in understandable, absolute terms, whereas an RT score do not (Horne & Burley, 2010). The KSS is, although subjective, a validated measure of sleepiness where studies comparing the KSS in relation to both EEG and RT tests found that KSS reflects a more objective sleepiness score (Horne and Burley, 2010; Åkerstedt and Gillberg, 1990).

1.5.2 Objective measures

In relation to the subjective measures, there are also a number of objective measures used in sleepiness research. Some of the most frequently mentioned objective measures are the electroencephalogram (EEG) which measure brain activity, The Psychomotor Vigilance Test (PVT) and the electrooculogram (EOG) which measures eye movements.

The EEG and the EOG are physiological measures which have been used excessively in sleepiness studies, both in a controlled laboratory environment and in more practical studies with driving subjects (Åkerstedt & Kecklund, 2000). The subject's sleepiness will show through low levels of alpha activity (4-12 Hz) and the eye movements will become slow and rolling along with long blink durations.

The PVT is a reaction time test where the test subject's reaction time is measured through a computer test where a rolling digital clock appears in front of the subject, and the subject has to respond as quickly as possible. The PVT has been proved to be a reliable indicator of sleepiness when using a 10 minute test procedure, and somewhat reliable using a 5 minute test procedure (Loh, et al., 2004).

Due to the need for advanced equipment and excessive planning in order to use these objective measurements, none of these objective measurements will be used in this study.

1.6 Countermeasures

Car drivers use a lot of different countermeasures in order to fight sleepiness.

Anund et al. (2004) did a survey study where 3000 subjects (62% answer rate) were randomly selected from the Swedish car registry in order to investigate what information drivers need to be able to recognize the feeling of being fatigued, realize the danger of being fatigued and finally to encourage fatigued drivers to take a break. The results showed that the process of recognizing and dealing with fatigue could be described through the sequence in Figure 3.

This sequence highlights situations where a driver could counteract fatigue and sleepiness through the use of countermeasures. In order to be able to act against fatigue, drivers first and foremost need to be aware of how fatigue feels and how to recognise the feeling of fatigue or sleepiness. As seen in Figure 3, drivers also must want to apply the right countermeasures which do seem to be a very obvious step, but this step refers to situations where drivers think of themselves as able to predict the imminent sleep onset, which is a false belief (Anund, 2010). On the same theme, Horne and Reyner (1999) discuss the process of recognizing sleepiness. Horne and Reyner argue that the amount of accidents related to sleep could be reduced with increased driver and employer awareness regarding the risks and consequences of sleepy driving.

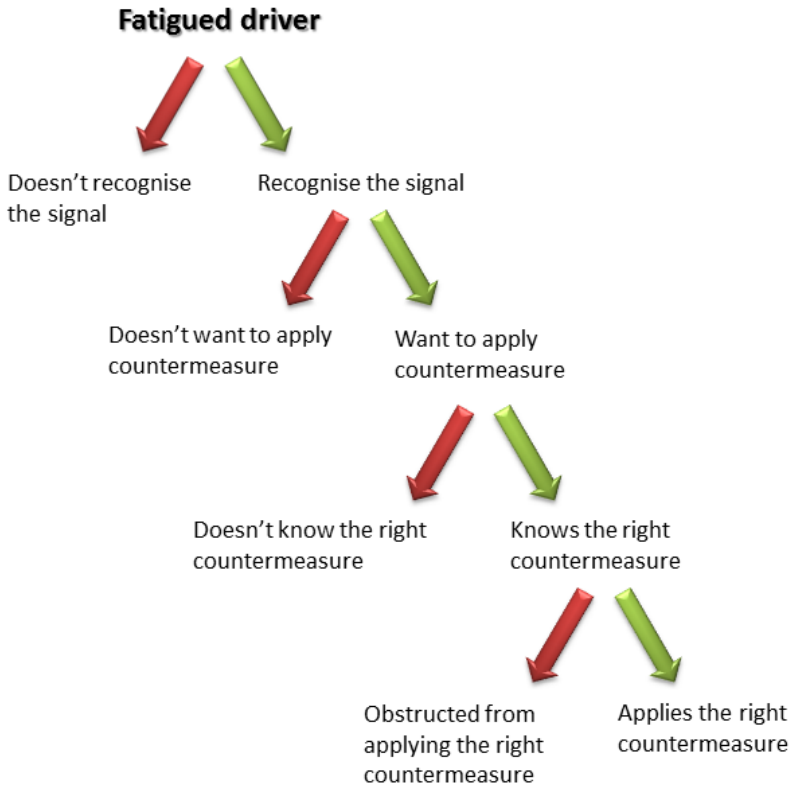


Figure 3 The process of recognising the sleepiness signal and choosing the right countermeasure. Adapted from Anund et. al (2004)

Drivers use a lot of different countermeasures in order to counteract fatigue. Anund et al. (2008) used the data sample from Anund et al. (2004) in order to further evaluate the countermeasures drivers used when feeling sleepy while driving. The results showed that the most common countermeasures was to stop and take a walk, turn on the radio/stereo, open a window, drink coffee and ask passengers to engage in conversation. The results also show that even though drinking coffee was rated high, the other most effective countermeasure (stop and sleep) was practiced by only 18 % (Anund, et al., 2008). The authors also discuss the pattern for applying countermeasures and say that it is likely that drivers have a tendency to use a countermeasure that allow them to keep driving. Horne and Reyner (1999) describe how drivers instead of using countermeasures such as turning up the radio should recognize this as an indication of beginning sleepiness. In situations like the one described, drivers should pull over and sleep for approximately 10-20 minutes and possibly combine this nap with caffeine intake.

Åkerstedt and Kecklund (2000) write in their review that the only cure for sleepiness is sleep, even in the form of naps. They describe how naps as short as 15 minutes have an increasing effect on alertness. Short breaks or pauses are said to have a positive effect on alertness, but that sleepiness often quickly increase to the level before the break as quickly as within 15 min (Åkerstedt & Kecklund, 2000).

1.7 Safety management and Human Factors

This section aims to describe the field of human factors from a general perspective and what can be done to prevent accidents and errors in larger organisations. As the FRM-perspective implements Reasons theories regarding safety management, his models and theories will be used in this study.

1.7.1 Human Factors

In order to make an organisation safer, one first and foremost needs to have some kind of measurement, or at least a foundation to describe or assess the safety situation in an organisation. Reason (2000) points out that organisations of today commonly assess their safety by the number and severity of negative outcomes during a period of time. The problem is that a low number of accidents do not automatically translate into a safe organisation.

Reason (2000) describes two approaches that can be used to describe problems or incidents related to human error; the *Person approach* and the *System Approach*. The person approach credits the error to the individual working in the 'sharp end' of the system where typical errors are caused by deviant mental processes, such as forgetfulness, inattention etc. The system approach concentrates on conditions that influence the work situation, trying to build defences for these conditions with the goal to avert or lessen the effect of an error. Reason points out that the core of these approaches is that even though it is more satisfying to blame an individual for an error, the conditions influencing the individual in that particular situation are still present even after the individual is removed or replaced.

Reason also describes individual and organisational accidents (see Figure 4) through the use of the 'Swiss cheese' model (see Figure 5), where the slices indicate layers of defence and the holes represent the active failures (errors and violations between the human and the system) and latent conditions arising from the failures of designers, builders and maintainers to anticipate all possible scenarios (Reason, 1998). In the ideal world the slices do not have holes and the system would never fail, but in this model the holes are ever-changing and appear randomly across the slices, opening and closing according to local circumstances and latent conditions.

Individual accidents	*Organisational Accidents*
Frequent	Rare
Limited Consequences	Widespread Consequences
Few or no defences	Many defences
Limited causes	Multiple causes
Slips, trips and lapses	Product of new technology
Short 'history'	Long 'history'

Figure 4 Factors distinguishing the characteristics of individual and organisational accidents. Adapted from Reason (1998, P.295).

Reason describes an ideal safety culture as "*the engine that drives the system towards the goal of sustaining the maximum resistance towards its operational hazards, regardless of the leadership's personality or current commercial concerns*" (Reason, 1998, p. 294). A big part of this resistance is the possibility of using 'free lessons' as a foundation to improve safety in the organisation. These free lessons are the mostly inconsequential errors that could have caused injury or damage (Reason, 2000).

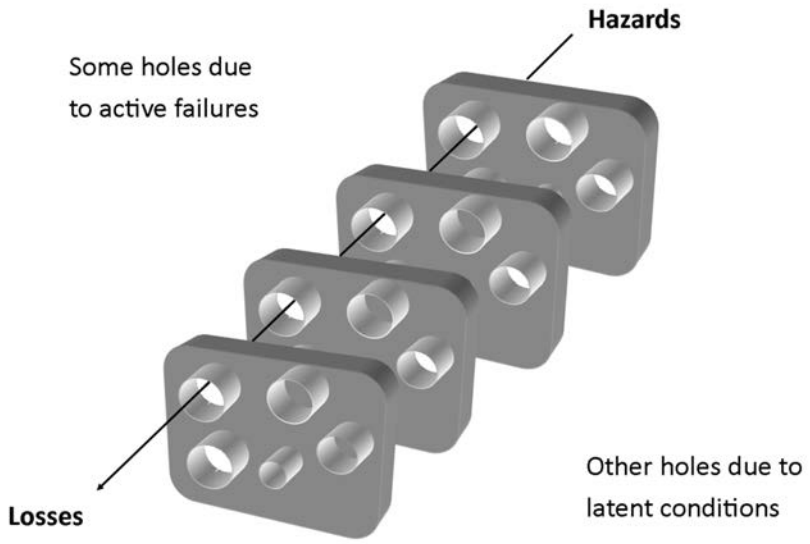


Figure 5 - The 'swiss cheese model'. Adapted from Reason (1998)

In order to make full use of these possible free lessons, employees need to feel that they can share these potentially harmful moments with their supervisors without risk of negative consequences for themselves. The more you know about the incidents in the

organisation, the more you can do to prevent and minimize the impact and effects of future accidents and errors, close the holes in the cheese if you will.

1.7.2 Fatigue Risk Management (FRM)

An approach with its foundations in Reasons work is called Fatigue Risk Management (FRM). FRM has started to gain attention as a better way to handle fatigue related risks in complex organisations. The definition of FRM used is as follows: "…..*the planning and control over the working environment, in order to minimise, as far as is reasonable practicable, the adverse effects of fatigue on workforce alertness and performance, in a manner appropriate to the level of risk exposure and the nature of the operation*" (Gander, et al., 2011, p. 574).

Building on Reasons work, Dawson and McCulloch (2005) proposed a conceptual framework for developing a Fatigue Risk Management System (FRMS). Dawson and McCulloch describes five levels of identifiable hazards and controls, where the levels are concerned with drivers; Sleep opportunity, actual sleep, behavioral symptoms, fatigue related errors and fatigue related accidents. Also, they describe a wide range of possible control mechanisms such as HoS-rules, prior sleep-wake-modelling, prior sleep-wake-data, symptom checklists, self-report behavioral scales, fatigue proofing strategies, a safety management system error analysis system and a safety management system incident analysis system are all required in order to handle the complexity of fatigue risk management (Dawson & McCulloch, 2005). Thus, this conceptual framework has a clear focus on precautionary risk management as well as a clear system approach in Reasons view.

Gander et al (2011) defines a FRMS as: "*A scientifically based and flexible alternative to rigid work time limitations, that provides a layered system of defences to minimise, as far as is reasonably practicable, the adverse effects of fatigue on workforce alertness and performance, and the safety risk that this represents"* (Gander et al. 2011, p. 578).

Today there are some fatigue risk management systems in use in commercial road transport in Australia since 2007, of which there are two levels, the Basic Fatigue Management (BFM) and Advanced Fatigue Management (AFM). The BFM still are conformed to the HoS (Hours of Service)-regulations for Australia (14h work per 24h), but with increased flexibility. Furthermore, the BFM have additional standards covering scheduling and rostering, fitness for duty, fatigue knowledge and awareness, responsibilities, internal review and records and documentation (Gander, et al., 2011).

The AFM implement even stronger adaptations to specific conditions, as the safety management system and controls are tightly connected to the specific operation. Operators have to decide almost all limits within the system as seen in .These outer limits are based on advice from fatigue experts and experience from current industry practices and are not to be exceeded. (Gander, et al., 2011).

Table 1 The advanced fatigue management parameters from the Australian Federal road transport regulations. Adapted from Di Milia et al. (2011 P. 580)

Parameter	Normal operating limits	Frequency for exceeding normal operating limits	Outer limits
Minimum break in a 24-h period.	Operator to propose	Operator to propose	6 continuous hours or 8 h in 2 parts.
Minimum continuous 24-h period free of work	Operator to propose	Operator to propose	4 periods in 28 days.
Minimum opportunities for night sleep (between 10 p.m. and 8 a.m.)	Operator to propose	Operator to propose	2 periods in 14 days.
Maximum hours of work in a 24-h period.	Operator to propose	Operator to propose	16 h
Maximum work in 14 days	Operator to propose	Operator to propose	154 h
Maximum work in 28 days	Operator to propose	Operator to propose	288 h

Finally, Horrey et al. (2011) requested more understanding regarding the individual differences in relation to fatigue in order improve knowledge of fatigue contributing factors. On that subject Di Milia et al. (2011) have reviewed the literature in order to try to examine how several different demographic factors can affect the individual's response to fatigue. This is important as the knowledge regarding different demographic factors provide the possibility to improve existing fatigue risk management systems.

1.8 Aim

The overall aims of this exploratory study are to investigate how the truck drivers' experience, fight and counteract sleepiness in their daily work environment. In addition, social and organisational factors that may influence truck drivers' sleepiness during their daily work will be described from a fatigue risk management perspective. Implementations that might improve the fatigue management in the participating organisations will also be suggested.

Research Questions

In relation to the study's aim, the following research questions have been formulated:

- Are truck drivers' everyday work affected by sleepiness or fatigue?
- If yes, which sleepiness-related factors affect their daily work?
- Would changes in relation to the truck drivers' working situation make the driving less sensitive to sleepiness?
- Why do professional truck drivers choose to keep on driving even though they know that they are sleepy?

2 Method

In order to explore the research questions in relation to earlier research, a qualitative approach was chosen. This approach included focus groups, situated semi structured interviews and semi structured interviews with company representatives as well as self-stated driver sleepiness through the use of Karolinska Sleepiness Scales.

The purpose of the focus groups was to get a general introduction to how truck drivers experience fatigue and sleepiness in their work environment. The Situated Interviews was thought to provide opportunities to experience the truck drivers' act in their working environment and also get a first-hand view as well as feel of their work tasks. The Semi-structured interviews were conducted in order to get a company perspective on the findings from the situated interviews with the truck drivers. Finally, the KSS-scales provided an opportunity to examine the sleepiness levels of the drivers that had partaken in the study without the presence of an interviewer.

2.1 Focus Group

The study began with recruitment of truck drivers to a focus group, which would serve as an introduction to the sleep issues that truck drivers face in their working environment. The truck drivers were recruited through VTI's own registry of voluntary test subjects and phone calls to nearby companies and hauling contractors. Six male subjects were recruited to the focus group and relevant factors such as work experience, area of work, and age are displayed in Table 2 .

The focus group rendered about two and a quarter hours of discussion between the respondents, with occasional questions asked from the two present moderators. As the purpose of the focus group was to know more about their attitude towards fatigue and sleepiness in general, fatigue/sleepiness awareness and fatigue/sleepiness in relation to social- and organisational factors, these three areas of interest was written on a whiteboard during- as well as referenced to in the beginning of the discussion. The reason for choosing these four areas was that these four topics correspond to areas of interest in the fatigue risk management framework. A moderators' guide was also prepared, containing questions regarding these areas in case the discussion stopped (See Appendix A).

Table 2 Table describing the focus group participants.

Participant	*Age*	*Area of Work*	*Years as a truck driver?*	*Shift work experience?*
1	48	Distribution	25	Yes
2	59	Construction	37	Yes
3	45	Distribution	25	Yes
4	33	Garbage Trucking	9	Yes
5	19	Trailer	0,5	No
6	52	Wooden chips	30	Yes

Fortunately, most of the issues were discussed spontaneously and questions from the moderators' were often clarifying, in order to get some more focused attention on a subject or anecdote that was mentioned earlier. In these cases of clarifying questions the respondents often picked up the conversation again themselves, resulting in a total of five questions asked by the moderators during the whole focus group discussion.

To make the most of the opportunity, the whole session was recorded using a dictaphone. Both present moderators took notes throughout the session and sat down directly after the section had finished and discussed and summarised their own thoughts and observations from the focus group discussion.

The results from the focus groups was analysed using a modified version of the method described by Rabiee (2004), which resulted in the following steps of analysis:

1. Locate all sequences of relevant discussion through repeated listenings of the recorded material.
2. Categorise the most frequently discussed topics in relation to the four main areas of interest.
3. Select quotes that represent the topic and the respondents' mentality. These quotes are often reoccurring as well as being vocally supported by other respondents.
4. Finally, analysis of the context and how words are used revealed additional aspects of the truck drivers' situation (e.g. subjective feelings etc.).

The results from the focus group discussion came to be the specific factors of interest in the situated interviews.

2.2 Situated interviews – Truck Drivers

In total, eight situated interviews were conducted. The term "situated interviews" reflect the method used to collect data, where a participant observation was paired with pre-

formulated questions and specific areas of interest collected from the analysis of the initial focus group. The participants of the situated interviews are described in Table 3. One respondent was part of the initial focus group, another was recruited through VTI's database of test subjects and the rest of the respondents were recruited through references by the participating respondents.

Table 3 The respondents recruited to the situated interviews. The distance drived indicates the distance drived during one specific situated interview. Time of day indicates the duration of the work shift.

Participant	*Age*	*Gender*	*Area of Work*	*Years as a truck driver?*	*Distance Drived (Km)*	*Time of day*
QK	59	Male	Crane Truck (Construction)	37	130	8 – 17
DL	53	Male	Distribution	32	180	05 – 14
LL	58	Male	Distribution	38	360	04 – 14
QFN	52	Male	Long Haul	4	740	10 – 00
ML	51	Male	Distribution	2	175	15.30 – 00
KM	51	Male	Long Haul	33	560	17 – 06
CMD	51	Female	Distribution	8	120	06-15
NB	20	Female	Long Haul	2	400	16-02

The situated interviews were held during one work shift for each respondent. The interviewer participated in the work tasks when the respondent deemed it to be appropriate. Mainly the situations where the interviewer didn't participate involved handling machinery requiring some kind of licence or locations where the interviewer wasn't covered by insurance. In cases where the interviewer was unable to participate or even follow the driver, the drivers were asked to describe the working conditions on these locations, where the interviewer asked clarifying questions if needed. The experiences and answers was documented through field notes which further got digitalized and expanded in the style of a subjective description of the respondent's work day.

The analysis of the gathered material was done in an iterative style, with the initial goal of finding patterns to describe the truck drivers' work situation from a fatigue and sleepiness perspective. After reading both the field notes and the digitalized stories several times, the models of the drivers work shifts (see Figure 6) crystallised. Agar (1996) describes a funnel metaphor for analysing ethnographic data and the analysis can

be described as narrowing the field of analysis until the core findings remain.

Relevant fatigue and sleepiness related factors in relation to off-work and work situations	Time off work	Driving (early in the shift)	Loading cargo	Unloading cargo	Driving (Late in the shift)
Individual Goals					
Organisational Factors					
Social Factors					
Environmental factors					
Individual Countermeasures					
General aspects					
Culture					

Figure 6 The model used to describe important findings in relation to the chosen categories.

The same metaphor can be used for this study where the modeling of each respondent work shifts, according to the chosen categories (Time off work, Driving early in the shift, Loading cargo, Unloading cargo and Driving late in the shift). The modeling of the driver's work shifts helped to focus the analysis and also to point at certain organisational and individual possibilities of improvement. The drivers work shifts are featured in Appendix B. These contributing factors are the subject of later discussion in relation along with the Human Factors- as well as the Fatigue Risk Management perspective. In cases where additional or clarifying information was needed, the respondents were contacted and asked through telephone calls.

2.3 Karolinska Sleepiness Scales (KSS)

In order to examine the impact of sleepiness on "normal" shifts, without the presence of an interviewer, the respondents was asked to fill in Karolinska sleepiness scales (see Appendix C). The drivers were instructed to state their sleepiness once an hour during their work shifts, as well as food or caffeine intake, naps as well as medicine taken. The results from the KSS are compiled in diagrams in the results-section. Semi-Structured Interviews - Company Representatives

Three semi structured interviews with company representatives (employing 6 of the 8 participating drivers) was conducted after the analysis of the situated interviews was finished. The interviews were conducted in order to get a company perspective on- and contrast the findings from the situated interviews with the truck drivers. These interviews took place at the offices of the companies and were conducted with the help of a pre-formulated interview manual (See Appendix D). The interview-length varied from 40-minutes to an hour and the analysis of the interviews was done in the same manner as the situated interviews with the truck drivers. In order to make the most use of the data, all interviews were recorded.

3 Results

This section aims to present the results of the focus group, situated interviews, KSS-scales and the interviews with the company representatives. The aim is to display different fatigue contributing factors as well as the opinions of truck drivers and company representatives.

3.1 Focus Group

The focus group rendered about two and a quarter hours of discussion between the respondents, with occasional questions asked from the two present moderators. As the purpose of the focus group was to know more about their attitude towards fatigue and sleepiness in general, fatigue/sleepiness awareness and fatigue/sleepiness in relation to social- and organisational factors, the results and analysis regarding these specific areas will be presented under separate headlines below.

3.1.1 General Attitude towards fatigue

There was an overall consensus in the respondent group that fatigue and sleepiness could occur during any part of the day and at any time during the working shift. As exemplified with the following statement regarding fatigue in the working situation:

> *"Fatigue has nothing to do with the days, it can strike an hour after starting work or late at night, that depends on how that particular working day is."*

The respondents moved on to discuss a large number of factors in the working and driving situation that they felt contributed to their fatigue and sleepiness. The most frequent and widely recognised factors was; to work outside in cold or stressful conditions and then moving in to the warm cabin to drive, monotonous and boring roads, driving with bright lights in heavy snowfall or behind another truck with strong back lights. One of the interesting topics regarding fatigue contributing factors was the fact of driving with a sleeping passenger riding in the cabin. This was described as very tiring by many of the respondents. This is not mentioned in any of the literature on fatigue and sleepiness among truck drivers.

This is somewhat in line with what is found in the literature, regarding the fatigue contributing factors as described in Thiffault and Bergeron (2003) and Anund et al. (2004). Although the general consensus regarding physical or cold work and afterwards moving in to a warm cabin was a factor that emerged through the focus group that isn't mentioned in any literature regarding fatigue and sleepiness contributing factors.

3.1.2 Fatigue and Sleepiness awareness

The respondents showed through their utterances that they recognise the feeling of fatigue and sleepiness in their daily work. Many of the respondents own statements described that fatigue and sleepiness was recognised through different kind of cues, such as one was late to switch down the lights, driving on rumble strips or that you forgot if you had yet to come to or just left a destination, as described below:

> *"When you then come and drove on Norrköping, I was so fucking tired once, that I felt: Am I going* ***to*** *Norrköping or am I going* ***from*** *Norrköping? I had no idea until I saw the first sign."*

Some of the drivers described that they had experienced a state of lessened awareness during driving.

> *"One knows that from driving night shifts that you could have driven many many miles and then suddenly you return to consciousness and cannot remember what happened. I went through Tranås many years ago; I do not even remember that I passed through the town with all the red lights and everything."*

Some anecdotes regarding severe sleepiness from the focus group include hallucinations, such as one driver who had stopped several times because he kept seeing policemen standing at the side of the road, waving for him to stop. Another driver reported once seeing a moose fully draped in reflector tags. Both these experiences caused the drivers to immediately stop and take a walk round the truck in order to wake themselves.

Generally, the respondents seemed to be very aware of their level of fatigue and also that the moment of sleep onset is very unpredictable, but occasional mentions indicate that they maybe do not always stop when feeling sleepy or fatigued. For example this following utterance spontaneously mentioned in the general discussion may be indicative of other non-mentioned situations where drivers fought fatigue rather than stopped:

> *"Fatigue may disappear although one hasn't rested".*

The discussion and analysis regarding non-stopping situations will be expanded in the "Organisational Factors" section below.

Regarding countermeasures used the respondents often mentioned stopping the truck and walking around as one of the countermeasures used. To take a short nap was also mentioned as one of the used countermeasures, although the respondents also mentioned somewhat limited use of this method because of time pressure and lack of places to stop. Other countermeasures described was driving with windows down, or singing for themselves in order to be more vigilant.

Generally, these stories are interesting as the respondents describe situations where they have been very sleepy and yet kept on driving. Maybe because their awareness of fatigue and sleepiness were not that good in the particular situation or maybe because of some other contributing factor in their working environment. This discussion will be expanded in the "Organisational Factors" section below.

The respondents also asked each other about sleeping habits and how often the others were able to sleep for a whole night. Not many slept the whole night through. A short time later, when someone in the discussion mentioned that they often sleep better during the morning than during the night, the driver said the following during the discussion:

> *"I do not, I wake up every other hour."*

The drivers also mentioned that very few drivers say that they fell asleep if they have driven off the road. The general understanding was that they used some kind of excuse.

> *"Instead they say that they hit a badger or drove off the road because they made way for a moose, but there is no traces whatsoever from any moose nearby."*

This may indicate that drivers feel embarrassed if they fall asleep at the wheel and that it is seen as their fault for being sleepy. There is also a possibility that these common "excuses" are ad-hoc fabrications that explains their actions.

3.1.3 Fatigue and sleepiness in relation to social factors

Regarding the social factors' impact on the level of fatigue, the younger respondents seemed to experience more impact than the older respondents. This was shown through the initial presentation of the respondents, where the first thing mentioned by this particular respondent was:

> *"As a father of young kids, you are always tired."*

This respondent and his wife worked very irregular shifts, which left them with some limited spare time in the evenings, along with taking care of their two children. This led the moderator to believe that this particular respondent felt much influence from his social life on his level of fatigue at work. Other social factors mentioned were problems to sleep in the daytime, whilst working night shifts, as there are people that are not aware of your sleep need (such as neighbors) which can disrupt the sleeping period.

One driver mentioned that he had light sleep apnea, and that he felt the effect of it sometimes. He recognized the feeling of being dry in the mouth and throat along with not feeling rested while waking up. If he felt this way and his working schedule allowed it, he would sleep a half an hour longer. Other ways for him to counteract his sleep apnea was to position himself straight when he slept, which he also felt made difference.

Generally the social factors in relation to fatigue and sleepiness where the one area that the subjects spoke about the least, but when they were spoken of the subjective impression from the moderator was that it were the younger respondents that had the most opinions regarding these factors, mainly because one of the respondents experienced the social factors mentioned on a daily basis.

3.1.4 Fatigue and sleepiness in relation to organizational factors

The area where the most of the focus group discussion was categorised to was the organisational factors. Much of the discussion was focused on effects of shifts, schedule, drive and rest time and also the drivers' general control of their working period.

One of the central themes regarding the organisational factors was that the respondents often talked about how they did not have so much control over their working situation. Often do the effects of any unexpected delays seem to return to the truck drivers. For example, if you are delayed while loading your cargo, some drivers mentioned that they switched their tachograph to 'rest' in order to save driving time for later when they are about to go home.

The pressure that could be experienced in relation to fatigue and the very tight working schedule was also discussed. The respondents felt that there were no margins in their schedule and when they felt that they needed to stop, they couldn't, as exemplified in this statement:

> *"- You cannot say that you are so tired and will sleep because you have had too little sleep, because then you are done.*

"-Then you do not need to go back there anymore. "

This of course puts a lot of pressure on the drivers to drive even though they are very sleepy.

The group went on to discuss GPS-receivers and how one of the trucking companies in town had fitted all their trucks with new tachographs and GPS-receivers, which the respondents felt was to monitor every move of their employees during the working shifts and also to reduce time where the trucks are standing still. From an observer point of view this felt as distrust from the truck drivers directed towards the trucking companies. This could possibly be an indication of some of the problems in the relation between the truck drivers and their superiors.

The inflexibility of the drive and rest regulations was also a reoccurring topic during the focus group. The respondents felt that if they had driven four and a half hours and switched cargo, they were forced to stop even though they still felt alert and vigilant. The respondents felt that this 45 minute wait while still feeling alert caused them to feel somewhat stressed, partly because they had to sit and wait out the 45 minutes, and partly because they might need more rest on the second four and a half hour period when the fatigue sets in. As described through the following quote:

"…down there you should take a 45 minute break, but when are alert, the ride down there goes well, but then I just sit there for 45 minutes just to be allowed to go home again, when it is on the way back one gets tired. That's when one could use an hour to stop, but then there is no time, you can't take another break."

Another organisational aspect of the work that the respondents discussed was the effect of shift work, which the respondents found had a major impact on their experienced fatigue and sleepiness levels. Different periods of shift work were discussed and the general consensus was that longer periods of shift work were better, because the body gets time to acclimatise to the new routines. This particular respondent thought that even a week was a too short period to work changing shifts. This led one of the respondents to talk about a union that has regulations which state that no one can work more than three consecutive night shifts. This leads to a switch in working once every three, sometimes two days. This one time day shift was described as:

"You just exist. You are not to much use at all."

One should also point out that some good examples of organisational regulations were mentioned during the focus group. One of the drivers described a situation where he had drove to Gothenburg and there got help to unload his truck, while he could walk across the car park to a barrack and sleep for some time there. That was recognised as a good example among the respondents, although some said that they often never got any help to unload their trucks.

3.1.5 Overall summary

The situations described by the respondents in this focus group are indications of the pressures they experience in their working situation. There seem to be many different factors influencing the fatigue and sleepiness levels in a truck drivers work environment.

The general impression from the focus group is that the truck drivers seem to have a demanding task to perform. On one hand they are very service minded and want their customers to be happy, on the other hand they themselves always have to take the consequences when something does not work as expected. This was shown through the statements made regarding the inflexibility of the drive and rest times.

The biggest point of discussion was about the drive and rest times, and the inflexibility of the regulations. Often they feel the need to move the rest times to a point when they really feel that they need a break and do not need to drive just to make it home in time.

There seems to be some kind of distrust between the respondents and their own superiors, which can be described through the quotes from the GPS-related discussion. Fatigue Risk Management relies on a high level of trust between the "sharp end" and the "blunt end", in other words that drivers shouldn't be afraid to report fatigue related incidents and near misses to their superiors in order to show when fatigue and sleepiness is experienced as a problem by the drivers.

3.2 Situated Interviews - Truck drivers

This section will present and discuss the data collected and analysed from the situated interviews. The results described in the following sections will provide the foundation for further discussion. The following sections contain a wide range of different factors that are of interest for the upcoming FRM-discussion.

The sections below following the segments that describes a driver's work day in the following segments; Time off work, Driving (early in the shift), Loading cargo, Unloading cargo and Driving (late in the shift). As there are interesting factors that does not respond to any particular area of a drivers work day, they will instead be summarized in the "general"-section.

In order to secure the anonymity of the participating drivers, no circumstances regarding specific driver's shifts will be described. Instead, forms like "drivers working night shifts" will be used and the aim is to describe conditions without specifying factors like night or dayshift. Further, the words 'they' or 'their' will be used in order to secure anonymity for drivers in specific situations.

3.2.1 Time off work

In most of the interviews the drivers clearly states that they highly value their spare time. Many drivers describe meeting and participating in other family members' activities as ordinary spare time happenings. Aside from family activities, many drivers talk of interests or hobbies that play a big part in their social life, such as exercising or an interest in sports apart from the ordinary household chores one must do.

On the other hand, some drivers experience that they miss out on social activities because of their work hours. For example one driver was living alone and working night shifts while most of their friends worked day shifts. This resulted in that much of the spare time was spent alone. In this particular case the driver contrasted the limited social activity during the working week with a full time job and good pay and the possibility to see friends and family during the week ends.

The majority of the drivers feel that the received compensation in extra time off work makes up for long shifts or early start times. Some drivers are very explicit in this statement; "*If it wasn't for the compensation in time off work, nobody would do this*". Even if one is

forced to commit to two full days of work and forsake social life in-between these work shifts (both occurring among observed night and day shifts around 12-14 hours) the drivers feel that the compensation in extra free time is fair.

When asked about sleeping times, the majority of the drivers said that they tried to get about 6-7h of sleep. Some drivers sleep less, about 5 hours and one driver had a very interesting strategy to their sleep. This driver described how they adjust sleep time in relation to an upcoming work shift. If it is an easier shift, they need 4 hours of sleep and if it is a tougher shift they need 7 hours. The way that the driver plans their sleep time according to work shift is fascinating. This may indicate that the driver feels so secure regarding their work tasks and the effort that these demand that they feel that this regulation of sleep time is safe and manageable. On the other hand it is possible to see this sleep regulation as unnecessary risk taking from the driver, jeopardizing both the driver themself and other fellow drivers' health.

Some drivers describe how their children are grown up and because of that their social life does not get affected by their work times as much as when their children were younger. This may implicate both a responsibility and a desire to spend time with one's children, but also that small children can have a somewhat negative impact on a driver's recovery whilst off work. This responsibility aspect is exemplified by a driver that stated; "*Every day I wake up and thinks that tonight I am going to bed early, but something always come up. Kids homework, household chores, football or something else on TV*". In this study, none of the interviewed drivers had small children at the time of the situated interviews, but the way a driver described their social situation in the initial focus group; *"as a parent of young kids, you're always tired", may imply some social impact on the individual fatigue and sleepiness levels*. This may suggest that drivers have a harder time to get the required sleep and rest for work when they are parents to small children, due to irregular sleep time etcetera.

3.2.2 Driving early in the shift

When driving early in the shift, the interviewed drivers often comply with an individual or formal plan for the day. This might be a schedule provided by the company, regarding when and where they should load or unload, take breaks, or call to see if there is any more work to do. In other cases a driver knows only from the waybills where their stops are and plan their own unloading schedule. This is of course very different to the long distance routes, where the drive to the loading site consumes almost all driving time in the HoS (hours of service). During longer working shifts the driving speed on the highways is about 85-90 km/h. This is 5-10 km/h faster than the speed limit for heavy trucks and the driver describes this speed as "*the perfect driving speed, because one get down well in time for unload and at the same time it do not use too much fuel"*. Another reason for driving precisely at 85 km/h they say, is because 85 is right at the point where traffic police can begin to fine truck drivers for speeding. The driver also express that they can't drive legally (80 km/h) as it becomes "*too stressful"*. Another driver describes this speed limit violation (90 km/h) as "*necessary in order to make it in time*".

These statements highlights a very interesting aspect of the general observed truck driver work situation in relation to route planning, namely that some of the drivers feel that driving inside the speed limits isn't enough to feel relaxed and comfortable in relation to the driving schedule they have. This might put unnecessary pressure on truck drivers and stress them to break the limit in order to comfortably make it to the terminals in time for load. During the interviews there seem to be some "grey areas" in

some parts of the truck drivers work situation, where the drivers *have to* adapt in some way in order to meet the demands of the situation. Typically, these adaptations only bring negative consequences for the truck drivers themselves. This is important, as these pressures may have an additional influence on the truck drivers' own level of fatigue during their work shift. More examples of what I refer to as "grey areas" will be presented and discussed in later sections.

All of the drivers in the interviews use cruise control when driving on highways and other "bigger" roads which drivers often describe as "*monotonous*", "*dull*" or "*boring*". Many drivers describe how they often choose smaller roads over the bigger, just because of the level of activity that is required to drive on smaller roads as well as a more interesting landscape. It is more difficult for drivers working night shifts to use these types of countermeasures, particularly during winter time where "*you could work and live entirely in darkness*". This expressed awareness regarding monotony could be interesting to keep in mind, as monotony is proven to be a sleep contributing factor. Clearly, the drivers are aware of the impact of monotony and choosing roads that require a more active driving style is one way for them to counteract monotony.

Drivers also describe that difficult weather conditions is a fatigue contributing factor, as one is always tense because of the difficulties driving a large equipage during the winter. For instance one driver describes it as "*harder to relax because of the difficulties of determining where it is slippery or not*". Drivers driving long haul routes describe how it is impossible of keeping the same times during winter and summer. If something happens, they are forced to stop and take a break according to drive and rest regulations, but if the truck is supposed to be used right after this particular driver's shift, then they sometimes choose to keep going. In these cases they print a receipt from the tachograph and write down the cause of the infringement, hoping that the policemen will understand in case they get stopped. A driver described the situation the two previous winters as "*impossible to follow the drive and rest regulations, as one is forced to drive at 40 km/h for long periods.*"

Many drivers describe phone calls as a frequently used countermeasure against fatigue, especially among those that work night shifts. Many drivers describe having a number of friends that they call during the longer drives. This is probably the most frequently mentioned "active" countermeasure, since most of the truck drivers drink coffee anyway and not with the specific goal to counteract fatigue and sleepiness. Some drivers also mention that the cabin temperature is an important factor when counteracting fatigue and sleepiness. "*It is better to freeze than being too hot*".

3.2.3 Loading cargo

The loading situation is very different among the observed drivers. Some drivers do not need to touch the cargo they are carrying at all, while other drivers' biggest challenges lie in the load and unload of cargo.

On the near area distribution routes, the drivers knows from the first look on the waybills and the cargo where and what they will drive on the work shift. A driver describes this moment as "*the most exciting part of the day*", as the driving and destinations are well known for all the observed drivers. The drivers that do not have a schedule or plan set by the company plan their daily route individually. One thing that all observed drivers are concerned with is the loading order of the cargo. Depending on which sort of cargo, if the cargo is frozen or chilled for example, the drivers load their

truck in relation to their schedule in order to streamline the unloading procedure and the route as a whole.

The loading procedure is closely related to the type of cargo and is also more or less relevant for the driver depending on other factors, such as if one also have to bring home objects from the customers as there are places left to unload, this planning becomes even more important in order to keep in time with the schedule.

The loading procedure is very different among the observed drivers, but in relation to fatigue and sleepiness the biggest contributing factor observed is excessive and sometimes unnecessary physical work during the load of cargo. Drivers mention both work injuries and huge weight loss (26 kg) due to the fact that their work is so physically demanding. Drivers also describe how they are told by their supervisors not to use electric forklifts, as the force of the forklift could damage poorly packed goods. Since the company has been charged for broken goods, the company told the workers not to use forklifts and instead load the cargo by hand. This is another example of these grey areas, where the driver in this case seems to face the conflicting interests of two companies. On one hand the customer, whom from the driver's perspective could make sure that their goods is packed correctly and on the other, the driver's own company which does not want to be fined for broken goods. So the driver keeps both companies happy in this case by loading the cargo by hand. When one look at this from a bigger perspective, if this physical work is to be repeated later in the shifts, where one should load a full equipage again after unloading and several hours of driving one understand the situation a bit better. A driver described the physical work and the technique used to load as quickly as possible as "*you begin pulling two at a time, but because the trailer has a slight tilt upwards, in the end you only manage one*". This is but one of many examples of the service mindedness that the observed truck drivers display, along with a tendency to get the work done rather than pointing out different problem areas. More examples relating to situations like these will be described further in the upcoming sections.

Other drivers describe difficulties in getting hold of an electric forklift and when one gets hold of a forklift, you stick to it. In order to make one's own load as easy as possible, for example when ones cargo hasn't arrived, you help other drivers load and unload just so you could keep the forklift. This is seen as an indication of how important these aids are to some drivers.

Many drivers load cargo in colder temperatures, alternating between 4 and -25 degrees Celsius. Some drivers also feel that loading cargo in these temperatures have an impact regarding ones level of fatigue as well as sleepiness. Not while they load, but when they get out in the warmer cabin and are about to take off. All observed drivers use thicker clothes while working in these colder temperatures. It is important to point out that not all drivers express these effects of working in colder conditions, although some do and that's important.

3.2.4 Unloading Cargo

In the same way that load procedure and conditions differ among the observed truck drivers, the same goes for the unload procedures. Some drivers do not need to unload the cargo they loaded in the beginning of the work shift, others neither load nor unload their cargo and some both load and unload the cargo they carry. When one further consider the different types of shifts, destinations and surrounding factors that influence unload of cargo, the situation quickly becomes increasingly complex.

For instance, drivers that work with local distribution mentions a wide variety of factors in that they feel contribute to their levels of fatigue in relation to unload alone. Among these factors are disputes with customers about the service they provide, other truck drivers that occupy gates for a long period of time or "steal" spots at unloading sites, physical work at unloading sites in relation to poor maintenance and bad weather etc.

During the time spent with the drivers working distribution, the physical aspect once again is very prominent. In the cases where there's much physical work the drivers does not have the possibility of using electric forklifts, due to narrow or non-existing loading bridges or Spartan methods of unload (i.e. no other possibilities apart from more physical strength). This is of course problematic as the drivers in some cases cannot use aids provided by the companies, which renders them useless in these situations. A driver also describe how the unloading process is calculated, meaning that different types of cargo have different unloading times as they more or less easy to unload. These unloading times are according the drivers often based on the quickest drivers, as they save more time and therefore also money. If one can't keep up with these times you become stressed and feel the need to compensate by carrying even more etc. *"Other drivers might take twice as much at a time, but I choose not to because I do not want to hurt my back"*. This may cause a negative spiral, where drivers feel that they need to cut time in an already tight schedule. This will be discussed further in the "general" section.

During the winter drivers working distribution routes describe the conditions as being tougher, as ice and snow makes it harder to unload. This is mainly because carts and other carriers get stuck in the snow and it is difficult to get a secure foothold. This of course is also problematic in the cases where drivers have a time schedule to follow, as longer times to unload also inevitably leads to delays further down the route. In the event of a delay, all the observed drivers working distribution can call either the company's traffic control or the customer themselves and reschedule the arrival times. During the interviews it was clear that the physical work is very tiring. The drivers are very service minded and often compromise with more personal effort when problems arise. Examples from the interviews are that a driver for instance describes carrying cargo by hand from the truck to the customer for six months, as the loading area was affected by maintenance work. "*Even if this isn't a big part of my total cargo, it is still tiring*". This may seem as a minor problem, but as the cargo was a daily dose of 150 kg of meat there is a significant rise in workload.

Other drivers describe disputes with personnel at the stores where they deliver cargo regarding where their service actually ends, as customers often want service that exceeds what the delivery contract states. The driver in question stated that they often do this kind of service as they do not feel comfortable in this discussion. "*It may not seem as a great amount of of time, but if these extra services take around five minutes and you have 10 stops in a day, it quickly becomes a lot of time that the company do not get paid for*". Drivers also describe that they are often caught in the middle when something happens. This could be a delivery according to the contract (unload at the loading bridge), but as different drivers have different procedures (some drives the goods all the way in to the cooler), the particular customer expected a different service (and didn't check the loading bridge), and the drivers company is forced to compensate the cargo (which is deemed bad due to health regulations).

All drivers are very efficient as they unload cargo, something that reflects the tight margins on the routes. Many drivers describe how they can be more efficient as they have earned the trust of the customers and therefore have permission to use the facilities, doors and in some cases the personnel do not even check temperatures on

delivered goods. Many drivers often have a relation with personnel at the sites, as the drivers often have worked these routes a long time before. The interaction with known personnel is often cheerful although somewhat casual and in some cases even friendly. Many drivers describe being a social person as a very important for drivers in the distribution business, as one is the company's "*face towards the customers*".

As the drivers working distribution have much more time spent with tasks regarding load and unload, much of this section focuses on findings from distribution routes. On long haul routes the larger terminals provide electric trucks and good unloading conditions. The problems the drivers in this study face regarding fatigue are more closely related to long wake times and night shifts.

3.2.5 Driving late in the shift

Regarding driving late in the shifts, the drivers describe many of the factors mentioned in the previous "driving early in the shift"-section. Phone calls, driving conditions and monotony for example, are things that reoccur in late shift driving.

A majority of the drivers regulate and also violate scheduled breaks and drive and rest regulations during the situated interviews. Examples of this is to put the tachograph in rest-mode while unloading or loading and taking a 15 minute break after a quick drive around the parking lot. The reasons for these infringements are varied but the statements can be summarized as:

A. A desire to get home as early as possible.
B. The schedule is too tight for breaks.

Many drivers reasons comes down to these two key factors, this is understood through clear statements and a common understanding. The drivers clearly know that this is an infringement, but as one of the interviewed drivers described it; "*one should really take a little break, but there are some so-so with that. The important thing is that the truck is standing still*". This is a core statement regarding the problem with infringements of drive and rest regulations. If a driver knows that they could get home and in bed an hour earlier if they just set the tachograph in rest-mode during load or unload, the temptation is hard to resist.

The other aspect of the problem is that drivers feel that the amount of work expected and the time they need to perform this work in, simply isn't compatible. In earlier sections, drivers own statements regarding time and comfortable working conditions are mentioned and the problem is equally, if not more present in late shift driving. In late shift driving you feel the stress that have been built up during the work shift, especially if you know that there is a colleague waiting for you and the truck once you get home. Many drivers describe that it is harder to stop and take a nap or a break if they know that someone needs the cargo or the truck (or both!) just after their work shift is supposed to end.

These infringements are not visible in the system as such. You cannot trace either of these described violations from the collected tachograph material, but still they paint a picture that is correct according to the drive and rest regulations. This false belief goes both ways, as reason A benefits the driver and reason B benefits the company. This problem will be further discussed in the "general" section.

Most drivers describe a situation where you allow yourself to relax as very dangerous. It occurs mainly when you are close to home, or when you are finished with the most demanding work tasks. Many drivers describes this state of mind as "*I've made it", "just this little bit left to go", "nearly there"*, etc. When you allow yourself to relax you get sleepy very quickly.

Regarding countermeasures, the drivers drink coffee as much as the next man which is one of the countermeasures, along with naps, that is proven efficient in counteracting fatigue and sleepiness (Åkerstedt & Kecklund, 2000). Apart from drinking coffee, drivers mention phone calls as a good way to counteract fatigue, as previously mentioned in the early shift driving. Drivers also mentions short breaks, where they stop their trucks and take a quick walk around the parking spot and have some fresh air. Drivers further describe how they try with different countermeasures before actually stopping. Drivers describe opening the window, counting car numbers and eating as other countermeasures in order to reduce fatigue and sleepiness. One of the drivers took a nap break during one of the interviews, something that is standard on their route they explained. Many of the drivers talks about naps and seem aware of the positive effects they have, but at the same time they do not mention naps as a frequently *used* countermeasure. The overall impression is that drivers seem more likely to use countermeasures that allow them to drive at the same time, rather than to stop and take a nap.

3.2.6 General

This section will highlight certain general aspects of the situated interviews that are common across all interviews and also pick up on subjects that have been mentioned in earlier sections and discuss them from a general perspective.

The observed problem with the infringement of drive and rest regulations in previous section is problematic with regard to driver fatigue. Many drivers describe that there are some drivers that are eager to show their capability and in order to do so they try to execute their work tasks as quickly as possible. These drivers can force their way before other waiting drivers in order to save time, for example. A driver describes the problem as "*the people that stress do not get anything in reward for stressing and cheating. It is the legal drivers that get affected*", meaning that the legal drivers are the ones questioned as someone can drive the same route as them, but an hour faster with no visible violations in the tachograph. Other drivers describe how their schedule gets tighter and tighter, as one gets used to the routines and demands on specific routes you are able to do the work faster. This progress of tightening the schedule and cutting time is something many drivers experience. One can describe it as "fastest is the new baseline" meaning that if someone can do it at this rate, everyone can. Drivers also describe how their supervisors sometimes fill in on their routes and get easy loads as the personnel at the terminals know that the supervisor is driving, which also can add to a somewhat false belief regarding the demands on a specific route.

This tightening of schedule is more profitable for the company, as you could transport more goods in less time, but from a fatigue- and sleepiness perspective it is problematic. These mainly because it demands more physical effort and cheating with regulations in order to make it in time. A driver describe how they often (1-2 times a week) work 14 hour shifts where there isn't time to take proper breaks or drive inside speed limits during the whole shifts in order to make it home in time before another driver begins their shift with the truck they use. Clearly this isn't a healthy work environment.

On the other hand, some drivers interviewed seem very keen to cut time and get home before their schedule ends. A driver even articulated from the beginning of the work shift that getting home early is a goal for the shift, saying that "*you never sleep as good as when you're getting paid for it*". Instantly, this was thought to mean that the driver meant that they felt free to take naps during the shift, but this belief was altered during the interview. In this case the driver wanted to use 15 minutes of rest time before leaving the loading site in order to get home earlier. As other drivers in the interviews also did set the tachograph in rest-mode before leaving the loading site (15 min), this is also an alternation of the drive and rest regulations in order to get home earlier. In the interviews there were some drivers that finished before the scheduled finishing time. As this tactical behaviour was identified as important in the latter interviews there are not any explicit notes regarding how much faster the shifts were performed, although the field notes do mention the end time of the situated interviews.

This slight optimisation, both regarding the long-time planning perspective and these shorter "false" breaks, also contributes to a false view of the work load regarding the specific routes. Even if the drivers in question feel that they can handle driving long distances without the need for rests, this still might be very difficult for a driver that is new to the route for example, since the current drivers might contribute to a certain belief regarding the particular route shift. Just because the working conditions are personalised, it do not necessary mean that they are good in relation to fatigue and sleepiness.

Many drivers say that they generally do not feel so sleepy during the work shift. Many drivers working late shifts or night shifts also say that they are more of an owl, which may indicate that they in some way have adapted to their late work shifts. But when asked for signs of sleepiness, when they experience that they are sleepy, they often state signs of sleepiness that are quite severe. Drivers express experiences like; "*Feeling dozy*", "*a hanging head*", "*hard to keep eyes open*", "*slow mental response*", "*driving onto rumble strips*", "*nodding off*" etc. as signs of sleepiness. These statements are signs of sleepiness that are quite serious as many of them indicate sleepiness at the brink of actual sleep. Drivers saying that a slow mental response is a sign of sleepiness describe these situations as "*difficult to maintain a phone conversation"* and another driver described how "*I saw that the truck was heading outside the lines on the road, I was aware of it, but I turned back first after I've hit the rumble strip*". When asked what they do when they have these experiences, drivers say that they stop and take a nap. A driver stated that "*It is always better to come home sometime, instead of not coming home at all*", but at the same time said in the interview that the distance home also was of relevance, as they would solider on even though they felt sleepy if they was close to home.

This highlights a very interesting finding in the interviews, namely the impression that drivers do not seem to think of sleepiness as something bothering before they are on the brink of actual sleep. As mentioned in the "late shift driving" section, the drivers primarily use countermeasures that keep the truck running instead of stopping and this pattern seem to transcend here too. A driver also articulated that it is a somewhat "bigger" action to stop a truck rather than using another countermeasure, as you feel that a short break would be nice, you can't stop anywhere with a truck. You need to find a proper place to stop, turn the truck off and then later start and accelerate up to speed again. The driver said that this becomes a large procedure, and therefore it is more difficult to actually have a break if you feel for it. *"If you feel tired in front of your*

computer and you wanted a break, you could just turn the chair and walk away. It is a bit more difficult for me when I'm driving".

Regarding the responsibility regarding fatigue and sleepiness the drivers are clearly aware of their responsibility to be rested and fit for duty when they start work. During the interviews with the drivers there was one situation where the direct question regarding responsibility in relation to a sleep related incident felt right to put forward, and the driver said that they would not admit to sleep if they happened to have an accident because of sleepiness. "*I would say that I made way for something, a moose or something, because it is my responsibility to be alert when I'm driving*". This is very interesting, since the driver clearly is aware of their own responsibility regarding fatigue, but this may also be complicated in the situations where one get fatigued and sleepy *because of* the work one is doing. It is important to reflect on the fact that the work one is doing also contributes to fatigue and sleepiness, even if one was well rested when one started the shift.

Some drivers think it is difficult to take a day off when feeling sick, as supervisors may not be very welcoming, especially if they work uncomfortable hours. A driver describes working a whole week with fever, as well as having to stop the truck to puke during this working week. This is clearly not healthy. In order to lessen the risk for accidents related to sleep and fatigue, the least you could expect is that one are allowed to call in sick without any negative pressure. The driver also explained that it was a mentality that was taught in their home that one always should try even though one was sick and because of that they continued to work although fever. "*Maybe it is something one has got from home, the parents always telling one to try to go to school even if one felt sick*". In situations like this the driver themself has an individual responsibility to decide whether they actually is fit to work or not. But in order to do so the drivers clearly need to feel that the company supports them in these situations.

3.3 Karolinska Sleepiness Scales (KSS)

The KSS was handed out to the drivers in order to document how the drivers experienced their sleepiness during "normal" working conditions. Six of the eight interviewed drivers in the study completed the KSS. Some drivers' documented one working week and others documented seven days of work. The gathered results are described in the following diagrams (Figure 7 – Figure). The more detailed KSS-scores for each driver are described in Appendix E.

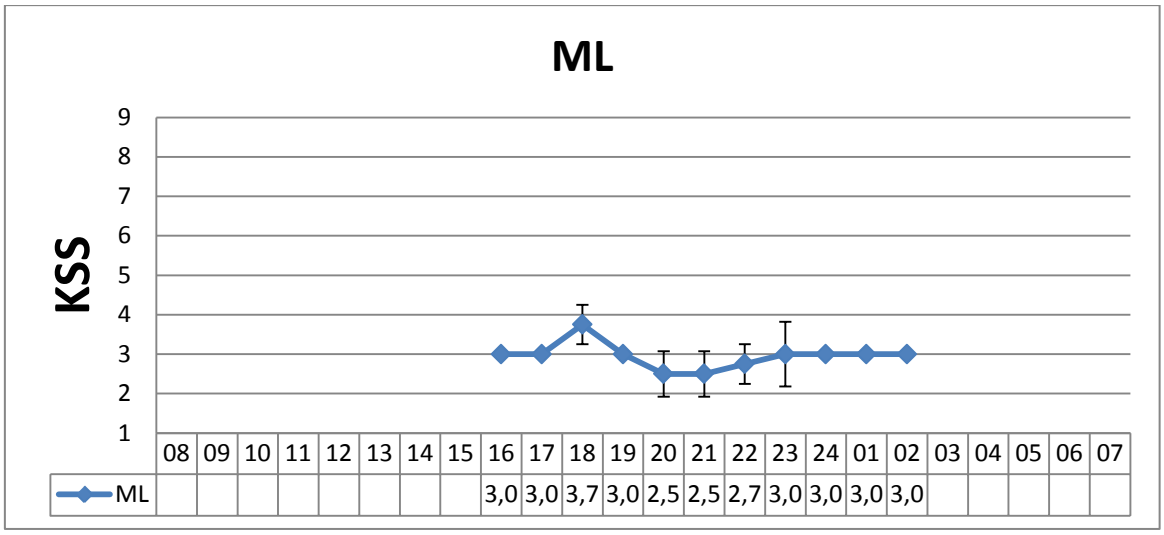


Figure 7 Average stated KSS-Scores for driver 'ML' along with standard error of mean.

This driver reported quite low KSS-scores, ranging from KSS 2 – "Very alert", to KSS 4 – "Rather alert". This driver had stated coffee intakes at 15 and 22 all days in the KSS, as well as no food intake during the work shifts.

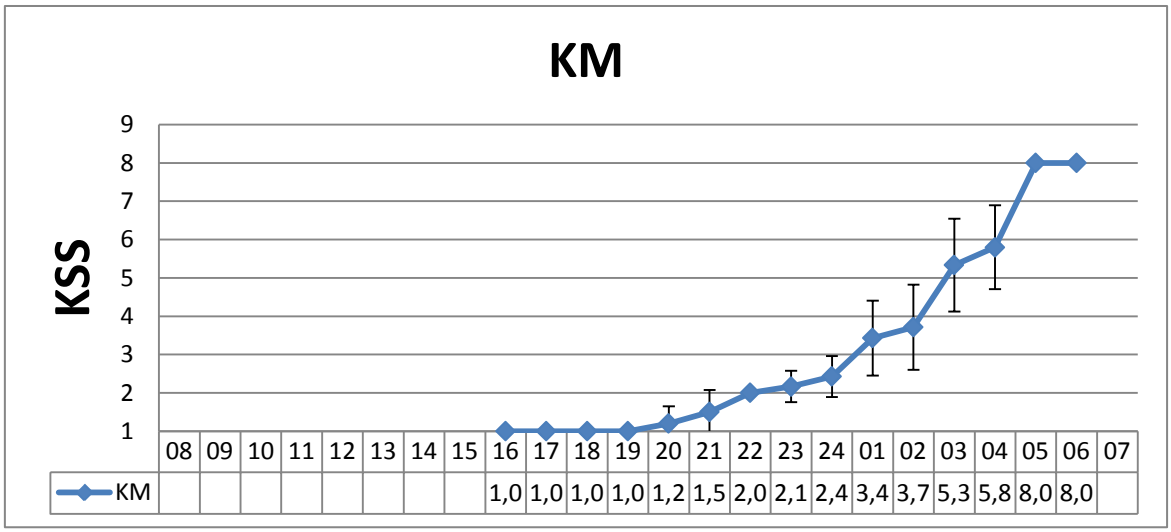


Figure 8 Average stated KSS-Scores for driver 'KM' along with standard error of mean.

This particular driver has a very clear rising pattern across all shifts, escalating in the longer shifts where the driver stated KSS 8 – "Sleepy, some effort to stay awake" during the last two hours of the two longest shifts. This is a statement of severe sleepiness. Also interesting to point out is that this driver is a driver with long experience of working night shifts.

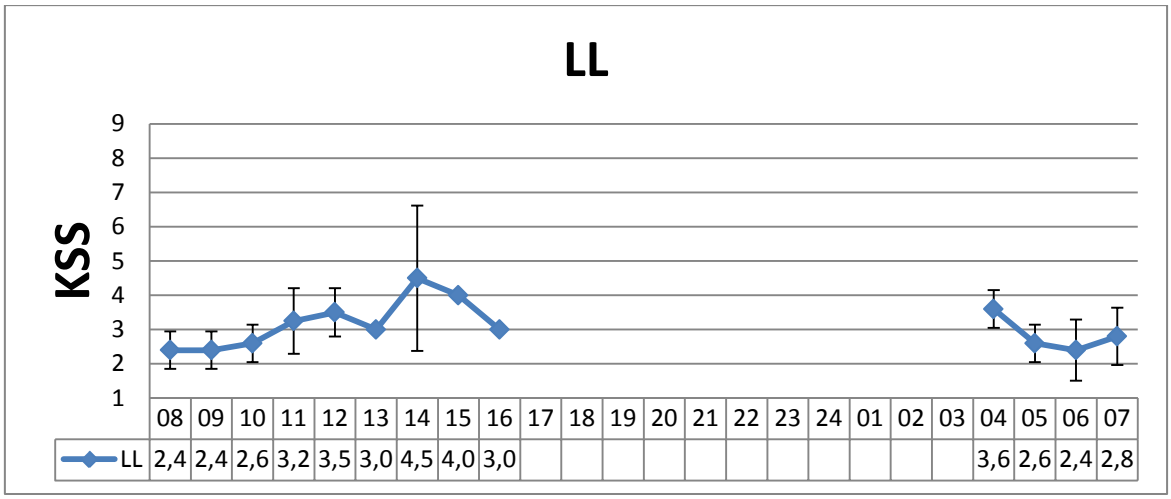


Figure 9 Average stated KSS-Scores for driver 'LL' along with standard error of mean.

This is the only driver that stated sleep during work hours, at 14 o'clock, after which the sleepiness level also seems to fall (only one shift lasted beyond 14 o'clock). This driver also had a physically demanding work situation.

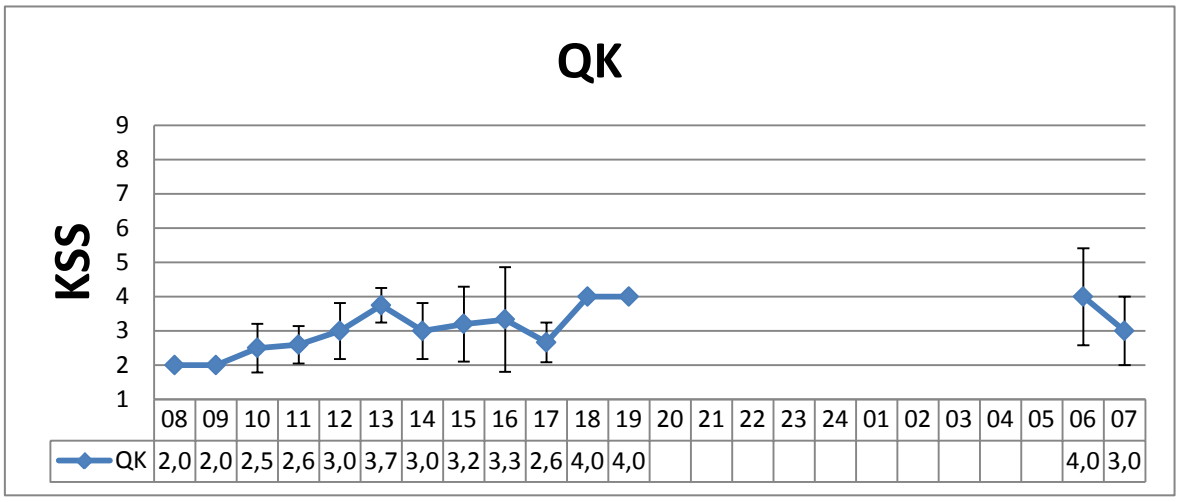


Figure 10 Average stated KSS-Scores for driver 'QK' along with standard error of mean.

This driver states sleepiness between KSS 2 and KSS 5, indicating no signs of sleepiness. This driver also had very varying work hours, both regarding length and time of day.

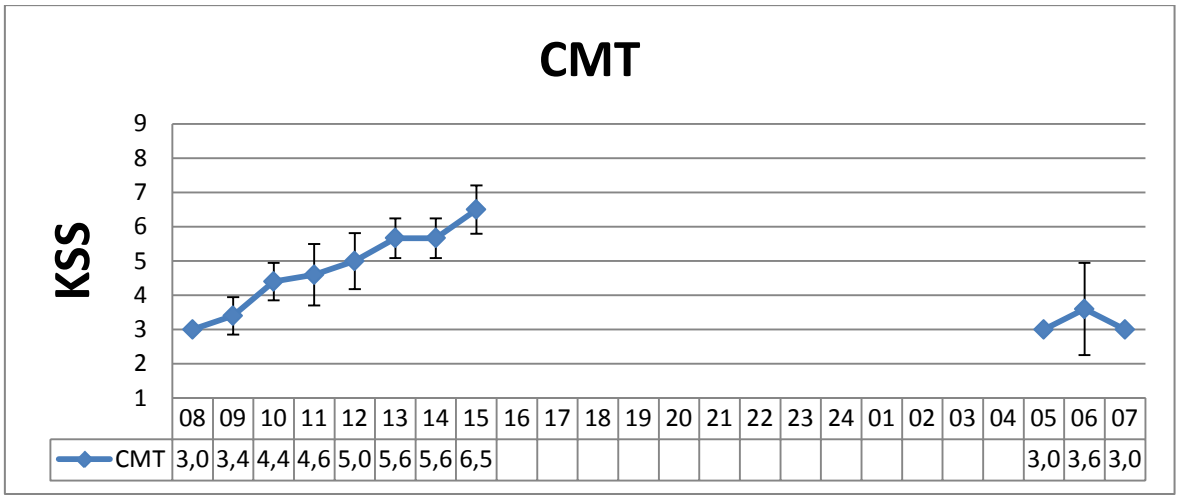


Figure 11 Average stated KSS-Scores for driver 'CMT' along with standard error of mean.

This driver seems to experience a rise in sleepiness as the shift progress. Interestingly, the driver states moderate levels of sleepiness in four of the five shifts. This is interesting since this driver work day-time shifts, possibly indicating that drivers' working day shift also feel strong effects of fatigue. This particular driver also had a physically demanding work situation.

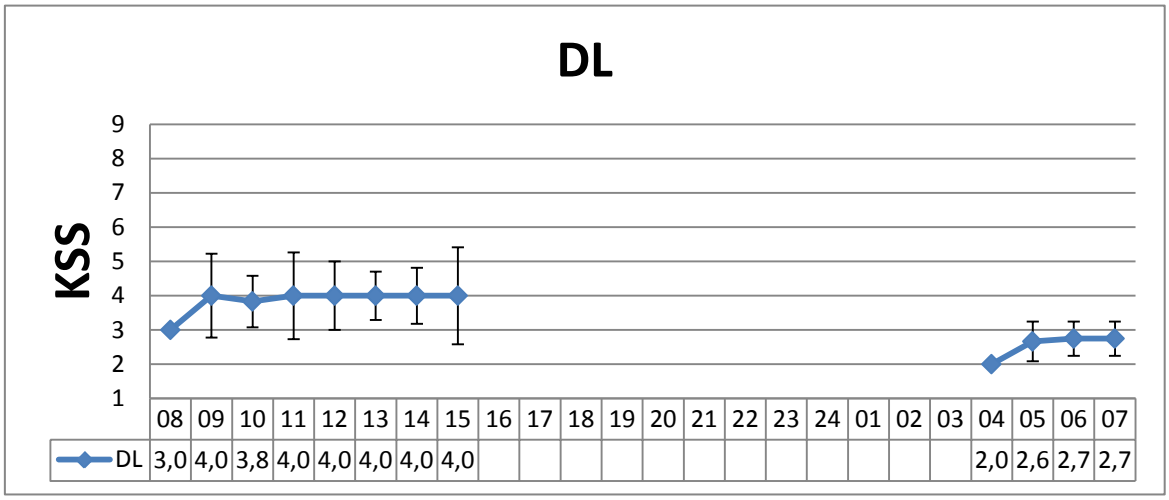


Figure 12 Average stated KSS-Scores for driver 'DL' along with standard error of mean.

This driver did feel some effects of sleepiness since there are some moderate statements of sleepiness (KSS 6) in the original scales. One thing that is interesting is that this driver also stated KSS 6 during shifts that ranged from 06-15 and 08-14, which are daytime shifts. Apart from that the driver seems to state higher levels of sleepiness as the shift progresses.

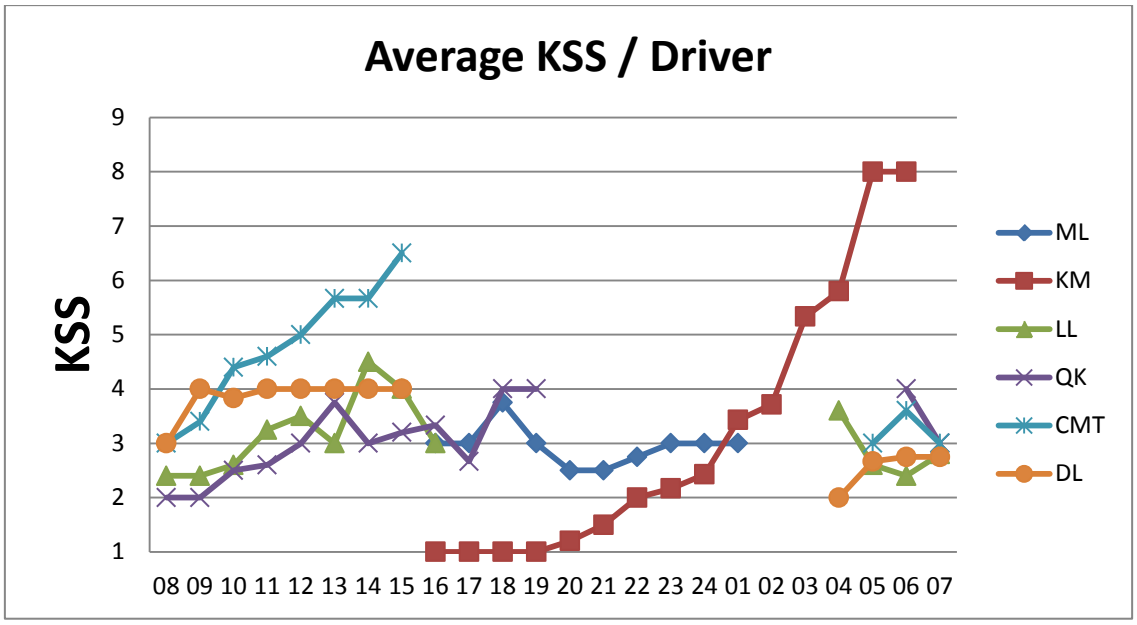


Figure 13 Average stated KSS-Scores for all drivers.

This diagram shows the average stated KSS during all the drivers worked hours. Interesting differences can be seen between beginning work at 04-05 versus having driven for 10 hours at the same point of time. Interestingly, most of the drivers seem to rate higher KSS values as the shift progress, apart from LL and ML. KM and CMT seem to feel most effect of sleepiness in their daily work shifts.

3.4 Semi-Structured Interviews - Company Representatives

After the situated interviews was finished and analysed, some semi-structured interviews with company representatives was held in order to get the company perspective on the findings from the situated interviews.

The interviews were held at the companies different offices and were conducted according to a pre-formulated interview schedule. The interviews were recorded in order to secure the possibility of revisiting the content and keep the quotes and answers as pure as possible.

In order to secure the anonymity of the participating companies or company representatives, no company names or names of company representatives will be described.

4 Scheduling and Planning

When analysing the situated interviews one get very curious about the circumstances surrounding the planning of work shifts and new routes. In order to know the premises planning new work shifts, the respondents was asked a series of questions regarding the process of initiating a new shift or route (see Appendix D).

The company representatives describes that often they get a question from a forwarder (sv: *speditör*) or they can bid on a new assignment. Often they receive some requirements, or premises, that they should deliver cargo from A to places B, C, D, E and F on specific times for example. As these criteria for the new route seldom fit the business perfectly, there is some negotiating and planning required before the business can be expanded. In order to make the business more profitable, the best solution for the company is to fit a new route into the business without buying any new trucks or trailers. Ideally, the new possible route fit a gap in the existing business, meaning that the company can utilise trucks and trailers that normally are not used during that time of day. The company representatives describe that this also need some planning, that they have to "*spin three to four trucks and move some cargo and finally you've created the space needed for this new route*".

Planning these routes and work shifts often relies on experienced personnel, which all have a long history of working in the company or in other trucking companies where a majority began to work as truck drivers. "*All of the guys in the traffic control are recruited drivers so no one can say that something won't work as these guys know what it takes out on the routes*". Many of the representatives still fill in for drivers and ride along during some shifts in order to maintain their knowledge of the business. "*I still want to know what goes on and how it works in the 'real world' "*.

When planning routes, two of the three companies say that they do not use any computer programs, instead they rely on their experience and a dialogue with the drivers. "*This is done without computer support; the traffic controllers have it in their cerebral cortex somehow*". One reason for not doing this is that "*such a schedule become more static, here you need to rotate and puzzle a bit*". The company that used a computer program had all regulations regarding scheduling implemented and also let the drivers exchange shifts in order to make it more flexible, as long as it does not interfere with HoS.

All interviewed company representatives rely deeply on dialogue with their drivers and relies on them to express and communicate the problematic aspects on the routes. All interviewed company representatives describe how the drivers on the routes have a say in the planning and normally it takes a few iterations in the schedule before the schedule can be implemented. "*We always plan a schedule according to the law, but there are always practical elements that do not work.* When the new schedule gets implemented, the company representatives describe how they immediately get response from the drivers on things that do not work according to the schedule. They then let the drivers work the schedule and after a few weeks they adapt the schedule according to the drivers' input. An important finding that was mentioned during the interviews was that during the planning of the routes, slack time isn't calculated with, as one can't afford it. "*We do not expect things to happen, it is when the problem arise that you have to deal with it"*. All of the company representatives state that there is always a possibility to call either the traffic control or the personnel at the destinations in case that something happens. Along with this statement all of the company representatives say that there is

always possible to quickly reschedule the loading times on a route, if the route is affected by road works for example.

A common theme is that the company representatives describe that drivers have a say regarding the schedule regarding how they want to work and how long. *"If a driver have to commute for example, he may want to work four shifts á 10 hours instead of five shifts á 6 hours a week"*. Some company representatives also mentions that drivers like to work longer shifts in order to get more time off work. *"Many drivers think that 'If I must work night shifts, I might as well work longer shifts and get more time off work-compensation'"*. This is a good example of how supervisors meet the desires of the truck drivers, but what might be a good way to keep drivers happy may be problematic from a fatigue management point of view. This will be discussed more in the FRM-section. Another problem for the company representatives is that they might need to meet these kinds of demands from drivers, as they might lose the good drivers if they're not happy about their working conditions. "*From one perspective there is a lack of qualified drivers today… there is a competition about the good drivers with a good reputation. If we give such a driver a schedule they isn't satisfied with, they can quit because they know that they can get work anywhere else… One can't do whatever one want, because then you lose your staff*".

On the other hand do the companies think a little bit different regarding the drivers social life for example, where some company representatives say that social factors are not "*any problems at all"* and they do this kind of adaptation often. Some other companies have a more strict approach. "*If somebody wants to work limited times and they have been here for a while we'll have a discussion…One can say that we try to adapt work times etc. a good staff policy, but we do not cuddle with the staff. You have your own responsibility as well*". This may indicate that in some companies, the drivers need to prove themselves before they get the benefits of working reduced time. Another finding that may support this hypothesis is that many drivers begin their career at a company by working part time and being "promoted" in some way to a full time driver. This will be discussed further in the *FRM*-section.

One of the companies said that they had a number of part-time drivers and pensioners that they call when they need extra drivers or if a driver is close to his weekly driving limit (e.g. week rest). This is mentioned as a very convenient resource for the companies to have.

4.1.1 Organisation and Fatigue

In the interviews there are some differences regarding whether their drivers are fatigued or not. One company representative responded "*of course they are*" and other representatives' say that their drivers are not so fatigued, because "*then we would have known it*". Again, the company representatives seem to rely on driver communication and dialogue in cases where something isn't quite right. All of the company representatives say that they have a big responsibility regarding the fatigue and sleepiness in their drivers.

One of the most interesting findings from the situated interviews with the truck drivers was that drivers mention how they have been told to not use forklifts and other aids because it increases the risk of damaging the customers' cargo. Another aspect of the same problem is the driver that felt that the discussion regarding where the service stopped was too tiring, which finally resulted in that they did more than the contract stated. This raised interest in how much the trucking companies can demand from their

customers, regarding these kinds of adjustments to customers. The company representatives generally said that they "*begin to be tougher regarding that, since the customer have a habit to put the responsibility for broken cargo onto us*". According to the company representatives, problems like this need to be addressed right away or at least documented on the waybills, at least in the case regarding the damaged cargo. This clearly seem to be a good way to handle the problem, but if the solution is as easy as this there is still a need to find out why the driver still express this as a problem.

The company representatives also collect a vast majority of information regarding drivers' drive and rest history, as the drivers need to report the activity on their driver's card every 28 days. These kinds of logs and reports are also checked and in case there are some violations the company representatives have a dialogue with the driver in question. One company representatives describe these kinds of data as a useful tool for the company, GPS for example. "*If one truck gets late to a destination time after time it is an indication that the schedule do not work. That does not necessary mean that the drivers miss their arrival times, but it is rather the route and the overall logistics that must work*". The company representatives also say that "*drivers have a tendency to gather time in order to get more spare time. That's the way it is"*, indicating that they in some way are aware of the violations of drive and rest regulations described earlier. Another situation described by the company representatives is that drivers in some cases have switched routes in order to get more spare time. The situation was discovered during a review of their tachographs and tachograph-prints by Swedish police. As the company have responsibility for this they were fined. The company representatives describe this as a problem related to the old tachographs and once all tachographs in the company become digital, "*this problem won't happen again*".

It was noted during the interviews with company representatives that there is an articulated element of trust in the relationship between truck drivers and their supervisors. Drivers have a huge number of factors to relate to and handle in their work situation and as one company representative describes it: "*For drivers today driving is the small thing. They must be able to handle computers, the waybill systems, health regulations, drive and rest regulations and other courses*".

When asked about incidents and accidents related to sleepiness, the company respondents say that they have had a very few number of accidents overall and only a small number of accidents related to sleepiness. In earlier sections it is described how a driver states that they wouldn't say that they had fallen asleep in case they had a sleep related accident. Instead they would say that they made way for an animal. In the interviews with company representatives they are well aware of this excuse, as one respondent said: "*Many years ago a holiday employee drove off the road and he said that he made way, but I do not think that he did because then he would have braked. There were wheel tracks, no signs of breaking. I have my theory but I can't prove it*". This is of course problematic as these situations cause mistrust between the supervisors and the drivers.

A company representative described that it is more common that younger drivers are involved in possible sleep related accidents. "*Traffic controllers know that if there were to call a 40 year old driver that got home at four o' clock in the morning, there is no use to call before one o' clock. If the driver is 20 years old, they can call at nine because he is up playing computer games. There is a bigger sense of responsibility in older drivers, I may be sticking my neck out, but that's the way it is*".

4.1.2 General

During the interviews with the company representatives there is a strong economic influence in every aspect of the companies businesses. One of the statements from the interviews that support this is the following: "*The trucking companies that drive long-haul traffic have an average profit margin of 2.5 %. That's low. For every 100 crowns you earn you have to plan so well that if you miscalculate 2.50 of these 100 crowns you have no profit*". Of course this has a major influence on the businesses. When asked about why the profit margin is so low the company representative responded with the following statement: "*I claim that it is the salary situation that has the biggest impact. There are Swedish companies that hire staff from Ukraine and Belarus, which earn a third of what Swedish drivers earn and that means that they can cut prices. We follow all collective agreements; have all insurances, everything that you should have. The only way for us to compete with that is to get as much hours on every truck*".

On the same line there seem to be certain differences in how flexible an organisation can be, depending on the size of the company. "*If a driver calls in sick two hours before they are supposed to work, we can call in another driver who does the work and when they finish they can stop the truck and sleep in it. We have enough trucks to make these kinds of rotations. We are not dependent on that specific truck. But if you have a smaller company, with two trucks for example, the situation is different*". This perhaps also relates to the flexibility within the company. As a smaller company you may be more dependent on your drivers working the shifts, as the process that follows when a driver calls in sick may be very complicated and troublesome.

As mentioned earlier, there seem to be a lot of responsibility distributed among the truck drivers, regarding what does and does not work in their work environment. All of the company representatives describe that they have a close dialogue with the drivers and that they rely on the drivers to tell them about when conditions are not acceptable. One of the company representatives describes how they have performance reviews with their drivers the drivers do not say anything about the conditions. "*When we have performance reviews I almost get angry at them, I want them to be angry and speak their mind. The worst thing is when people sit and just agrees with you. 'What do you think about this and that? – It is alright I suppose'. Everything* can't *be alright; there must be something that you think that we can improve in some way*". Some company representatives feel that drivers talk among themselves and do not communicate their problems to the supervisors. When asked for why they think that is they respond that "*I do not know, maybe that they look up to their boss in some way. A respect that gets a bit too big. You feel fine talking with your fellow employees. I think it might be that way, that's my theory*". This of course is problematic when much of the communication relies on dialogue. All of the interviewed company representatives describe how they have arranged different groups, often with one representative for a larger number of drivers that handle communication within the company. This is a way to handle problems that arise, but for example when a new route is arranged, they have closer contact with the drivers in question.

Several of the company representatives say that they trust their drivers to be well rested and fit when they start work, but this trust have also proven to be problematic in the past. A company representative describe this trust and responsibility as follows: "*We are the main employer, so we do not want our drivers driving taxi on the evenings where they should be resting*". This particular company had previously experienced problems regarding drivers having other jobs.

Another finding is that two out of the three interviewed companies had speed blocks implemented in their trucks, meaning that the maximum speed of the trucks is limited to 80-83 km/h. A company representative said that "*We do not want any discussion about this, we drive almost exclusively with truck and trailer and then the limit is 80 km/h*".

5 Discussion

In this section the results will be discussed in relation to earlier described theory in order to emphasize important findings. The discussion will be split according to the chosen categories, discussing relevant findings during each category as well as a specific section dedicated to countermeasures. Thereafter a FRM-focused discussion will discuss the findings in relation to a FRM-perspective and finally, a methodological discussion regarding the study's design and analysis.

5.1 Time off work

Regarding the drivers spare time it is clear that it is highly valued and some drivers seem to value their spare time more than others. Along the same lines some drivers seem to have adapted a kind of strategy in order to maximise their spare time. One driver stated that they need different amounts of sleep depending on their upcoming work shift and therefore altered the sleep amount between 4 and 7 hours. Another aspect of this problem is that drivers also seem to aim to get home early and in order to do so, they put the tachograph in rest-mode during unload or load. Therefore they seem to have taken the appropriate breaks in the tachograph data, when they actually haven't had any breaks at all and instead saved the rest time in order to get home earlier. From a safety point of view this is highly problematic, since these actions and the traces of these actions do not deviate from what's regarded as normal in the system. Even though the data gathered from the tachographs are correct due to existing regulations the "reality" behind these data is very different. This is an indication of how the traditional HoS-regulations are not enough to reflect, and in some way secure, if a driver acts safe or not.

Williamson et al (2011) discusses fatigue contributing factors and their link to safety. The authors describe a wide range of different studies where both the odds of the accident being sleep related and the threshold for increased risk multiplied several times beginning at 6 hours of sleep/night. Williamson et al. also mention that 4 hours of sleep during the last 24 h is enough to result in sleep-related performance problems. Clearly this tactic of sleeping 4 hours prior certain work shifts is highly problematic. In order to secure that drivers actually are well rested in the beginning of their work shift Dawson and McCulloch (2005) propose the use of an algorithm they call the "Prior sleep and wake model", which simply sets a criteria for minimum sleep during the last 24 and 48 hours. These criteria are to be determined by operators within the organisation.

Drivers are also aware of their responsibility to be well rested and fit for duty to start work. As Swedish law state that sleepy driving is equal to driving under the influence of alcohol, fatigued driving creates a moral problem area in the truck driver's work situation. This example of consciously planning one's own sleep might be adjusted with information regarding the importance of sleep before work, but it would also be very interesting to try to see how a different company and driver mentality might influence driver behaviour in situations like this. In this particular case, the subjective impression was that the driver associated this sleep planning as something one do to "play" the company in some way, but if the cultural values regarding fatigue among other drivers and indeed the company were different, perhaps this behaviour wouldn't continue in the same manner.

Some drivers also describe how the compensation in more spare time is a big reason to keep working long shifts. The company representatives also see this compensation as a

way of keeping the driver happy and that they in some way adapt the schedule to the driver's individual needs. This may be a way of keeping the driver happy, but as long work times is a known fatigue contributing factor it is hard to support this compensation from a safety point of view.

Wagstaff and Sigstad Lie (2011) reviewed a number of articles with a specific focus of long work hours and shift work. The authors found that work periods >8 hours carry and increased risk of accidents that accumulates to twice the accident risk of the 8 h work period when working periods are about 12 h. Thus it can be argued that long work times lead to greater risks in the organisation.

Many drivers and company representatives describe that there are a differences in mentality regarding fatigue depending on the age of the drivers. Some company representatives describe how the possible sleepiness-related accidents they have had in the company all involves young drivers and that younger drivers have a different attitude regarding sleep need than older drivers. This is also present in the interview with the young driver in the study.

This problem regarding the mentality among young drivers might be adjusted through a culture among the drivers. In this particular case there seem to be a difference in mentality regarding sleep need and the risks of fatigue. Perhaps the companies could use the older experienced drivers as some kind of mentors for these younger newcomers, introducing them to their way to handle fatigue and sleepiness.

5.2 Driving early in the shift

During the early shift driving many drivers have their own plans regarding the day's work. The drivers use this plan as an indicator of delays. As the type of work is very different, the plans and goals differ between distribution and long haul drivers. The long haul drivers often have one time to adapt to, whereas distribution drivers have several. Many know where they have to be at a certain time in order to make the schedule. As mentioned earlier, the long haul truck drivers feel the need to exceed speed limits as they do not feel relaxed when driving inside the speed limits. The company representatives state that drivers shouldn't feel the need to stress and that in most cases they have the possibilities to adapt the schedule to fit the demands of the route. Still it is interesting that some drivers feel that there is an element of stress regarding the scheduled times on the routes.

One possible explanation to this stress might be the way that the companies rely excessively on verbal communication from the drivers in order to uncover problematic factors on the routes. One company representative mentioned that some drivers do not mind speaking their mind regarding their work situation, but others seem to have a harder time doing it. This company representative's own theory was that the respect possibly becomes too big and therefore some drivers have difficulties with this form of communication. As a company representative, in order to get the drivers view of the situation there might be other ways of gathering information regarding drivers work shifts and the drivers own problem areas.

As all of the interviewed company representatives as well as many working in traffic control in the interviewed companies have experience from working, but it could be problematic to assume that all drivers share *their* view of what is problematic and what is not.

Reason (1998) describes the importance of a “reporting culture” as reports regarding problems help to unveil potentially harmful factors. There might be important to reflect about other forms of communication in order to report problems to the company representatives. Using anonymous notes or using the foremen men to report these kinds of problems instead of direct communication, could possibly be a way to uncover problematic factors in the organisation.

Another side of the problem might be that trucking companies might have to cut corners in the scheduling of new routes to meet the demands of customers and forwarders, as they too provide a service. As the economic margins are very tight they might be forced to compromise with the schedules in order to fit the new route into the organisation without the need for further investments.

Regarding the difficult weather conditions and their effect on fatigue, the drivers generally express that they can’t relax during driving in difficult weather conditions. As well they describe themselves being tense, they have often great difficulties in keeping the planned times on the routes. In these cases drivers call and re-arrange the specific times in order to fit the new driving conditions. As drivers and also some company representatives state that in cases of rough weathers they forsake HoS-regulations and keep driving in order to get home, while writing the cause of the HoS-violation on a printed receipt. This is seen as a result of the limited flexibility in smaller companies, since the company representatives in larger companies describe how they tell their drivers to stop and sleep in the truck when they for example are forced to work a night shift on short notice. These company representatives state that they have enough trucks in the business, which allows drivers in these situations to sleep before they drive back. This flexibility might not exist to the same extent in smaller companies, since they are more dependent on their trucks than larger companies.

This highlights a potentially bigger problem, since it is mentioned in the interviews with the company representatives that smaller companies might also have smaller flexibility in the organisation and therefore are more dependent on their drivers coming home as the truck is needed on other routes. This leads to drivers working very long hours in bad weather situations (around and above 16h) which are known to be fatigue contributing (Sallinen & Kecklund, 2010).

5.3 Loading cargo

The loading procedures are very different regarding which type of area the drivers work in. Generally the loading situation is quite good regarding aids, such as forklifts etc. but there are also some loading situations that are more troublesome to the drivers and these involve a lot of physical activity.

During the observations there were some cases of excessive and sometimes unnecessary physical work during the load of cargo. These drivers were forced to do unnecessary physical work because of either traditional loading methods or company directives. These company directives focused on the possibility of damaging goods and therefore drivers are told to load the cargo by hand instead of using forklifts (the cargo was packed in roll cages). These views are not found in the interviews with the company representatives. Instead, they say that have an influence regarding the loading and unloading conditions on the routes.

These conflicting views of company directives are either a result of poor communication within the company or a deliberate action taken by the company not

told of in the interviews. Since the existing reporting culture in the companies between the drivers and the company representatives rely almost exclusively on verbal communication, the drivers in question perhaps do not feel comfortable in protesting this company directive, resulting the company to believe the effects of this directive to be smaller than it actually is. On the other hand one could argue that the company does not benefit for having a driver that have to do unnecessary physical work, and therefore should make sure that the customers also have a responsible for maintaining a standard for packing goods.

There is of course a problem with this conflicting view and as mentioned above, a different kind of communication could perhaps be successful in situations like this. But equally if not more important is the company's attitude towards these kinds of problems. If the company *really* wanted the employees input and looked to deal with this problem the surely could have. After all it is a directive from the company that has the driver in question doing this physical work.

In order establish the loading conditions for all their drivers, the company representatives could ask for driver reports regarding difficult loading situations among all their drivers. In the case of any reports regarding problematic loading procedures, they could take a closer look or talk with the driver individually in order to find the best solution to the problem. The important thing in this procedure is that this kind of error reporting should be easy to do for the driver (Reason, 1998), in the form of a phone call for example.

Drivers also mention that temperature differences between the driving cabin and the loading terminal is felt to contribute to fatigue. In many loading terminals the temperatures are fixed at 4 degrees Celsius and some drivers clearly a state that going from this cold environment to a hot cabin is felt to induce fatigue. All of the interviewed drivers seem to prefer colder temperatures before hotter in order to counteract fatigue.

As one search the literature, one see that there are not that many studies (if any) that examines the relation between temperature shifts and fatigue. However, it is still important to raise drivers' awareness regarding this possible fatigue contributing factor.

5.4 Unloading cargo

Generally, the impression is that distribution drivers have a tougher situation regarding unload than long haul drivers and more specifically the distribution drivers that have cargo that require a great physical effort to unload. The drivers on these routes feel the effects of the different seasons, resulting in an even more demanding unload situation and further down the line an increase in fatigue because of this physical work. Further factors contributing to this situation are the unloading times for some distribution drivers which are based on the quickest drivers and the absence of- or impossibility to use their aids during unloading.

In order to compensate for this demanding unloading situation one might suggest that a schedule adapted specifically for these drivers are a good starting point. One of the interviewed drivers described how they had discussed with company representatives and traffic controllers regarding a sleeping break during the latter part of the shift, which were fine with them. This is the first step of adapting to the demands of a specific route, which seem to be a good example of positive interaction between the driver and the company.

Another way of improving these drivers' unloading situation might be to put more responsibility on the customers to secure acceptable unloading spots for the drivers, this resulting in drivers being able to use their aids on every stop on their route. Improving this aspect would probably result in less physical work, and therefore also a less fatigued driver. Even if it is hard to causally determine the results of these proposed actions, they provide a good starting point for lessening the effects of physical work in the drivers.

Regarding arguments with personnel where the driver's responsibility ends or begins, they perhaps should try to improve to communication to the company representatives regarding this problem. In these cases there might be much gained for both the company and the driver if these points of argument are cleared out. The drivers won't be questioned anymore and the company do not need to spend money on drivers doing tasks outside their contract.

Finally, it is also important to emphasise again that the main findings regarding unload of cargo comes from the situated interviews of the distribution drivers, because the unload situation in the long haul routes are generally quite good. This is thought to depend on that the main source of income for the companies is said to come from these long haul routes and therefore there might be a bigger focus on this part of the business. But if the standard actually is as good as observed, it might be time to look elsewhere in the organisation for troublesome unloading situations.

5.5 Driving late in the shift

In late shift driving drivers often regulate and violate scheduled breaks in order to get home quicker. This infringement is not be traceable in the software used to check the drivers' cards and their HoS-data, as the software only checks the thresholds for rest and driving.

Cutting corners in schedules, drivers trying to get home earlier or working the shifts faster is a problem both company-wise and safety-wise, since it maintains an illusion of a system where the drivers follow the regulations where they actually are not. If some drivers try to work their shifts as fast as possible and this does not look suspicious in the tachograph, this is described to put additional pressures on those drivers who follow the HoS. As some company representatives clearly are aware of these violations they describe that they try to make it clear for the drivers that cutting corners does not benefit the company. But this is also a very easy thing to say in an interview, rather than to actually make sure that their drivers do not cut corners on their working shifts. The reason for this doubt that some drivers state the need to exceed speed limits and violate HoS, as they simply can't make it home until the following driver begins and need the truck. These two sides of the story clearly contradict each other.

As described earlier these HoS violations go both ways and as long as there are not needs to examine the tachograph data in more detail this situation will not change. What is needed in order to stop this illusion of appropriate HoS is some kind of legislation or barrier that ensure that the correct breaks are taken and that work shifts can be allowed to take the time they actually take to perform. A possible barrier that could be implemented is to personalize the driver's card in order to match the received tachograph data to the driver's schedule. Since the planning already has been done and after the proper testing-period, one could link the planned schedule for the route to the

tachograph data and check if the times match. If the time taken to work the route is significantly less than the scheduled time, there may be need for further investigation.

In late shift driving drivers are most aware of stress that has built up during the work shift. Drivers describe how it is more difficult to allow them to stop when they know that another colleague needs the truck after their own shift has finished. One possible way to deal with this problem is to schedule a kind of minimum gap in the schedule between two work shifts, providing the possibility to rest if the drivers feel the need for it.

Drivers also describe how it is dangerous to allow one to relax, as the feeling of almost being finished or even having done the most difficult part of the shift almost instantly results in an increased level of experienced fatigue. As this phenomenon is described by many drivers in the study, it may be important to inform other drivers in order to raise the awareness of the phenomenon. This could be done through the use of experienced drivers teaching the younger, maybe in relation to the introduction of new drivers to the routes. As no companies describe using the experienced drivers in order to teach and inform the younger, although the younger are mentioned to be more likely to have fatigue related accidents, it might be an important step in the fatigue risk management and safety management development within the company.

When drivers are asked for signs of sleepiness when they work, the drivers generally describe severe signs of sleepiness. When drivers describe nodding off, a hanging head, driving on rumble strips or that the eyelids are heavy, these signs of fatigue are indications of a dangerous level of sleepiness. The drivers seem to be unaware of their sleepiness level until it reaches dangerous levels. Anund et al. (2004) describe a process (see Figure 3) that captures the problems to recognize fatigue and apply the verified countermeasures. One way to improve the drivers own awareness regarding fatigue is through education and information. The drivers need the tools to recognize early indications of fatigue in themselves, as well as the knowledge to apply the right countermeasure. This will be discussed further in the following countermeasure-section.

5.6 Countermeasures

The drivers apply a great variety of countermeasures when they recognise that they are fatigued or sleepy. Many are described in the results-section and based on these used countermeasures the impression is that drivers foremost use countermeasures that enables them to continue to drive, something mentioned earlier in the literature as well (Anund, et al., 2008). Some of the countermeasures used by the drivers, such as listening to radio or turn down the window haven't had a proven effect to counteract sleepiness (Anund, et al., 2011). Therefore, there might be a need for additional education and information aimed to educate the drivers regarding scientifically validated countermeasures. Closely related to this problem is one mentioned earlier; those drivers seem to have difficulties in recognising fatigue or perhaps the potential problems of fatigue and sleepiness (as described earlier by Horne and Reyner, 1999). If one looks at the KSS-scales a majority of drivers state KSS 6 during driving, which means that they experience signs of sleepiness. Perhaps information, such as having the KSS-scales visible in the trucks along with information regarding the risks of driving sleepy will help the drivers to be more aware of their own sleepiness levels.

Another interesting finding is the extended use of phone calls as a way to counteract fatigue. Some drivers describe talking in phone as much as 3 hours during a shift. Somewhat along the same line, drivers also describe how they sometimes choose smaller roads over the larger highways to fight monotony because of the higher level of activity needed to drive. Drivers also describes how stops and unloads help to fight the monotony of driving. This is very closely related to the study performed by Thiffault and Bergeron (2003) where the authors discussed other means of breaking the monotonous states. Perhaps this indicates that the phone calls help to break the feeling of monotony rather than counteracting sleepiness.

One important thing to mention are the company countermeasures; speed limit on trucks, using drivers that are employed by the hour when drivers have had reached their threshold allowed working hours (according to the HoS), gathering and reviewing HoS-data etc. All these actions provide a good foundation for relieving drivers of stress as they in some way try to determine the actual conditions for the routes. As one driver describes the feeling of having a truck that have a limited top speed, they say that they can't influence the situation and therefore they are able to relax. This kind of company countermeasures are important, as they take pressure off the drivers and also prevents them to drive faster in order to save and make up time. The speed limit on trucks is useful as it contributes to a company culture that resents stress and cutting corners on their routes.

5.7 Fatigue Risk Management

In previous sections there have been a number of different suggestions regarding how to deal with specific situations. In this section the aim is to point at some possible improvements in the observed organisations and systems in order to counteract fatigue. These points will be discussed separately below.

5.7.1 Today's HoS (hours of service)-controls are too shallow

During the situated interviews with the drivers and the interviews with the company representatives it became clear that the HoS-checks are too shallow. As today's controls only take the threshold values of drive and rest times into account, it might be necessary

to implement the possibility to match the planned work time to the drivers card data. This would allow the control to make sure that the time to perform the work shift matches the time that the shift is planned to take. Another advantage of this implementation would be that routes that demand HoS-violations in order to be carried out also would become visible in the controls through the implementation of these new matching criteria.

This of course adds more responsibility to the company and the overall tachograph-system in order to work, but the outcome would be a lot more accuracy in the tachograph data. Dekker et al. (2007) observed four different organisations as they tried to improve their learning from failure, and one of the organisations introduced changes to the incentive structure of pay, which perhaps also could contribute to less work under sleepiness and a more safe way of work in the observed companies. If the drivers were paid by the hour worked, with a maximum amount of paid working hours for each route, there might be less desire among the drivers to cut corners and get home early.

5.7.2 A more personalised approach to scheduling

Drivers must be allowed to have a more personalised driving schedule as different drivers have different needs regarding breaks. It is important for the drivers that they have the possibility to counteract fatigue and sleepiness when it suits them. As the company representatives state in the interviews that they have the possibility to quickly adapt delivery times and schedule according to circumstances regarding weather conditions and road works, one can assume that they also might be able to adapt a schedule according to a drivers need for rest.

On the other hand, some aspects of this personalised approach can also be problematic. If we think about the drivers wanting to work long shifts in order to get more spare time-compensation, this might actually be worse from a fatigue risk management perspective, since working longer hours is shown to contribute to fatigue (Wagstaff & Sigstad Lie, 2011). Perhaps this apply specifically to long working hours during night shifts rather than the day shifts, as the KSS-scores obtained for the driver working long night shifts seem tougher, where they stated their sleepiness level at KSS 8 (Sleepy, some effort to stay awake) in the final work hours during the two longest shifts.

There are several studies citing the problems of driving during the night hours, among others (Åkerstedt and Kecklund, (2001); Horne and Reyner, (1995)) and therefore night shifts might need different regulations (regarding breaks and shift length) than day shifts.

5.7.3 Need for a FRMS adapted to a company's situation

All companies perhaps do not have the same possibilities and flexibility within the organisation. If a larger company have the possibility to rotate among trucks and drivers in problematic situations and smaller companies lack this flexibility, there might be need for different FRMS. Companies may also differ in a lot of other ways, regarding which type of work they perform (crane trucks, long haul, distribution), management approaches etc. Thus, the companies themselves have to take responsibility for designing a FRMS that echoes the standard and principles and foremost the capability of their particular organisation.

5.7.4 Much collected data, but is it the right kind of data?

Today the companies collect HoS-data, data about the cooling systems, data regarding cleaning of the trailers etc. There might be a need to investigate the fatigue and sleepiness levels among their truck drivers, since truck drivers in the study experience periods of higher fatigue and sleepiness levels during their work shifts (higher than KSS 6). If the companies would start to gather voluntary data regarding fatigue and sleepiness from their drivers, they could get an accurate view of their drivers' sleepiness levels. This is seen as a starting point for the implementation of a FRMS in the organisation, as drivers seem to recognise sleepiness only at dangerous levels. Thus, this might be one way to have the drivers to think about fatigue and how fatigue affects them in their work situation.

An even better alternative to this is to have drivers inform traffic control (when that resource exists) when they are sleepy and have traffic control to reschedule destination times, tell the drivers to take a nap and write a report to inform other representatives.

Apart from collecting and evaluate the drivers fatigue level, there might be a need for company representatives to question their own and the company's ways of communication. All company representatives say in the interviews that they have a good dialogue with their drivers, although one company representative also reflects about the fact that all drivers are not comfortable with direct communication. As dialogue are standard there might be important to provide another kind of communication, perhaps anonymous, that drivers can use regarding subjects that they are not comfortable to discuss face to face. Company representatives might also gather anonymous opinions among their drivers regarding their own leadership and which way of communication they prefer.

5.7.5 The possible gain of a safety culture

As much of the discussed problems stem from differentiating views regarding cutting corners and violations of HoS, different attitudes towards rest, sleepiness awareness and company pressures scheduling and aids, there might be interesting to speculate regarding the possible impact of a safety culture (as described by Reason (1998)).

One of the company representatives describe how they strive for a feeling of togetherness in the company and this sense of togetherness is something to build on. In order to have a successful safety culture you need to have/implement some general features in your organisation:

Establish an understanding among company representatives and employers that accidents are merely the starting point of an investigation.

Gander et al. (2011) argues that the possibly biggest Achilles heel of a FRMS is the need for the employers, regulators and employees to be aware of the causes and consequences of fatigue, in order to meet their responsibility towards an FRMS. This is a large step, involving a lot of new knowledge and clashes with traditional perspectives.

Determine clear boundaries regarding accepted behaviour for both drivers and company.

If there are clear boundaries regarding accepted behaviour for drivers and company, you have the possibility to build on these criteria to ensure a better work environment for the drivers and more money saved for the company. Dekker (2009) discusses the problem with creating a "just culture" and concludes that normalizing and legitimizing incidents

(the biggest step to take), empowering and involving the practitioner him/herself, protect the organisation's data from outside probing and perhaps involve the prosecuting authority to integrate domain expertise. Dekker further writes that this require that previous mistrust is overcome and in the end, this benefits everyone through a better understanding of the point of view and interests for both parties.

Both company and driver need to give feedback on positive as well as negative behaviour.

Many companies in the study rely on drivers to voice problems, but if the mission is to reduce the fatigue and sleepiness risks, it is also important to reward that which is good. Not taking risks in relation to fatigue is to take responsibility, this goes for the company as well as the driver.

There is a need for a sense of trust between the company and the drivers.

As discussed earlier an element of trust between the driver and the company has a major impact on the organisations possibility to counteract fatigue and sleepiness. The drivers need to feel that they can share their near miss experiences without the risk of being punished in order for the organisation to learn, as well as the company need to trust the driver when the driver experiences a need to stop. If there is an element of trust, both the company and the driver will benefit from it.

Being fatigued and sleepy is human. It has nothing to do with truck driving skill, but it has to do with preparation and countermeasures.

In order to successfully minimise the risks regarding fatigue and sleepiness, both the drivers and the company must have knowledge regarding how to recognise fatigue and sleepiness and how to counteract it. This has the biggest impact in the organisation, as drivers need to know what is expected of them and the company must support the drivers in moments of sleepiness and not put additional pressure on drivers in risky situations.

Minimize the effects of environmental factors and physical labour.

Many drivers state that the effects of unnecessary physical work and environmental factors (such as temperature and loading sites) have a negative effect on their sleepiness levels. In order to minimize the effects of factors such as these, there might be a need for information and education regarding how physical labour and temperature factors affect drivers' sleepiness levels. Furthermore, the companies might have to take more responsibility in ensuring that their drivers are allowed to use the aids at their disposal, by putting responsibility on the customers in cases where they do not meet the standards of the contracts.

Examples of possible individual and organizational actions to perform in order to counteract truck driver sleepiness are shown in

Figure .

Possible ways to counteract sleepiness in truck drivers.	Time off work	Driving (early in the shift)	Loading cargo	Unloading cargo	Driving (Late in the shift)	General
Truck Driver	• Have appropriate sleep and rest before starting a work shift.	• Be aware of one's own sleepiness level (KSS). • Have knowledge about verified and efficient countermeasures. • Drive according to speed limits. • Report to traffic control or company representatives when one experience the need to sleep. • Report other problematic factors regarding driving to the company. • Give positive feedback as well as negative.	• Use forklifts and other aides when loading cargo. • Be aware of the effects of temperature when entering the cabin to drive. • Do not put the tachograph in rest mode while loading cargo. • Report bad loading environments (bridges, space, badly packed goods etc.) to the company.	• Use forklifts and other aides when loading cargo. • Be aware of the effects of temperature when entering the cabin to drive. • Do not put the tachograph in rest mode while unloading cargo. • Have clear instructions regarding what service the contract states. • Report bad unloading environments (bridges, space, aides etc.) to the company.	• Let the shift take the time it takes. • Be aware of one's own sleepiness level (KSS). • Have knowledge about verified and efficient countermeasures. • Drive according to speed limits. • Report to traffic control or company representatives when one experience the need to sleep. • Report other problematic factors regarding driving to the company. • Give positive feedback as well as negative.	• Have knowledge about the dangers of sleepy driving. • Report sleepiness contributing factors to the company.
Company	• Schedule work shifts that allows drivers' to have appropriate rests. • Be responsive to social factors in scheduling, although not meet the drivers demands of longer shifts.	• Fit a clearly visible KSS-scale in every truck. • Allow drivers to rest when the need is expressed and investigate the cause for sleep need. • Be responsive of drivers reporting problematic factors. • Fit a speed block in all company trucks. • Encourage volunteer drivers to report their sleepiness levels. • Have the older drivers to be mentors for younger divers. • Match the driver's card to the schedule for the route. • Give positive feedback as well as negative.	• Provide and encourage drivers to use aides (forklifts etc.). • Investigate bad loading environments on behalf of the drivers. • Have drivers share experiences regarding loading and techniques in order to share experiences.	• Provide and encourage drivers to use aides (forklifts etc.). • Investigate bad loading environments on behalf of the drivers. • Have drivers share experiences regarding loading and techniques in order to share experiences. • Be the medium between the driver and the customer in problematic situations. Establish procedures that don't contribute to driver fatigue.	• Fit a clearly visible KSS-scale in every truck. • Allow drivers to rest when the need is expressed and investigate the cause for sleep need. • Be responsive of drivers reporting problematic factors. • Fit a speed block in all company trucks. • Encourage volunteer drivers to report their sleepiness levels. • Have the older drivers to be mentors for younger divers. • Match the driver's card to the schedule for the route. • Give positive feedback as well as negative.	• Schedule work shifts that takes account of long working hours and night shifts. • Look for alternative ways of reporting problems and encourage the drivers to report problems! • Be responsive of drivers reporting about sleepiness contributing factors. • Investigate the driver's sleepiness reports in order to know what's causing the problems. • Encourage the drivers to education about sleepiness and how it affects performance. • Trust the drivers when they express the need for sleep.

Figure 14 Possible ways to counteract truck driver sleepiness.

5.8 Methodological Discussion

In this section the methodological aspects of the study will be discussed. The discussion will focus on the design and the analysis, discussing the chosen methods' impact on the study.

5.8.1 Design

The data collection was divided into four parts; focus group, situated interviews with truck drivers, KSS and interviews with company representatives.

When recruiting participants to the focus group and situated interviews the aim was to get a wide spectrum of ages, areas of work, experience and gender. Unfortunately there was no female truck drivers recruited to the focus group, since none of the asked female had the possibility to participate. In the situated interviews it was an active goal to get a wide variety of shifts, experience, ages, distances, areas of work and also to get some female truck drivers to interview in order to get as wide scope as possible. The truck drivers themselves proposed new contacts and helped to recruit new drivers to the situated interview. It is important to point out that drivers were also turned down, because their particular shift and experience was too similar to other shifts already covered and because of the intention to get a wide spectrum of drivers and work areas.

The participants of the situated interviews are mostly about 50-60 years old, which may had an impact on the gathered results. Older drivers may be more comfortable to speak their mind rather than younger drivers and they may also think different regarding sleepiness and how it affects them due to experience of sleepy driving.

The purpose of the focus group was to get an introduction to the drivers' experienced fatigue and sleepiness problems and it served its purpose excellently. Through analysis of the focus group data one was able to get a sense of the problems that truck drivers in relatively short time. The focus group generated a lot of points of interest for the upcoming situated interviews and the impression was that the topics discussed on the focus group strongly related to the situations experienced and discussed in the situated interviews. The discussion about countermeasures and signs of sleepiness in the focus group did correspond well with the statements from the situated interviews, along with the discussion about HoS. The completely new findings that emerged from the situated interviews was mainly traits and habits unique to the specific drivers such as physical labour, individual thoughts about sleep need and the drivers own experience of the specific company.

The situated interviews allowed one to experience the work environment together with the possibility of asking questions regarding different factors that seemed important. This way of collecting data did of course have an effect on the working environment for the driver, rendering the situation not being like a completely "authentic" work day. This was seen to a minor problem since the purpose of the situated interviews was to document the driver's interaction with the environment, not focusing solely on their experienced level of fatigue and sleepiness throughout the shift. In the cases where additional information was needed or data or field notes needed to be clarified, this was done through phone calls.

As the drivers level of sleepiness during the shift still was of great interest, the drivers were asked to fill in KSS-scales in order to document their self-stated level of sleepiness during a shift without the presence of an interviewer. These KSS-scales worked fairly well, where the drivers filled in the forms without anyone of the drivers calling

regarding problems. Still, the some of the drivers failed to remember to fill in all forms completely but the data was still useable.

The aim of the interviews with the company representatives was to contrast the drivers working environment with the view of the company representatives. The interviews provided an important contrast to the driver perspective, focusing on the demands of the organisation and how a trucking company is run. Although both company representatives and drivers seemed to be open minded and truthful in answering the questions it is something that one never can be completely certain of.

Generally, the design of the study have served its purpose well, providing an effective way to experience the everyday work environment of the truck drivers, as well as a possibility to contrast the truck drivers view with the views of the company.

5.8.2 Analysis

The analysis, although not intended, can be described as a “qualitative content analysis” as described in Graneheim and Lundman (2004). Graneheim and Lundman describe an interative and category-creating approach, which have many similarities with the analysis procedure used in this study. One of the few things that differ from their description of analysing qualitative data, is the structured way of anlysis, creating a clear path from original data (fieldnotes) to final results, which creates “trustworthiness” in the analysis. This path perhaps is not that clear in the analysis for this study, but this very fact provides a possibility to learn and improve in the analysis of future qualitative studies.

6 Conclusions

In this final section the core results will be discussed in relation to each of the research questions. Finally, some proposals for future research will be made.

Are truck drivers' everyday work affected by fatigue and sleepiness and what is the cause of the problem?

The drivers everyday work situation is much affected by sleepiness, some more than others. One thing that also is important to point out is that some drivers in this study meet many of the described fatigue contributing factors in their work shift simultaneously, which creates a complex situation. Many drivers in the study seem to experience signs of sleepiness every week during their work shifts. This is dependent of many things, but the main reasons in this study is believed to be unnecessary physical work, tight work shifts not allowing appropriate rests, a limited knowledge about sleep contributing factors and how these factors influence their sleepiness levels.

Would changes in relation to the truck drivers' working situation make the working situation safer regarding the problems with sleepy drivers?

It is believed that the implementation of a fatigue risk management system would improve the drivers work situation regarding fatigue and sleepiness problems. This would allow a more detailed and questioning view of the drivers work environment to be established, which would highlight new problem areas not previously thought of in relation to fatigue and sleepiness in the truck drivers' work environment.

Why do professional truck drivers choose to keep on driving even though they know that they are sleepy?

There are many answers to this complex question, but two main reasons stands out in this particular study. 1) The drivers keep on driving because they want to maximise their spare time in some way. 2) The drivers keep on driving because they feel the pressures from tight schedules and supervisors.

These two reasons co-exist and create a spiral that habituates drivers with violating the drive and rest regulations and the companies to demand more work to be done during the same shift times.

6.1 Future research

Some interesting things were found during the work with this study, which perhaps would be interesting to investigate. In this section, some ideas for future research will be described.

6.1.1 Female Drivers

Although the actual focus of this study is to describe how truck drivers work situation are affected by sleepiness, there have been some interesting findings regarding how the female truck drivers' experiences their work situation. The interviewed female truck drivers seem to be very aware of their gender in their profession, meaning that they describe a kind of doubt in themselves because of their gender. It would be very interesting to see some kind of sociological study focusing on how female truck drivers experience their work in a male-dominated profession.

6.1.2 Implementation of a FRMS

Dekker et al. (2007) describe the transition from the ’old view’ to the ’new view’ in a number of different safety-critical organisations. It would be interesting to see a similar study examining the same transition in a number of commercial transport organisations, documenting how they shift from an ’old view’ to a ’new view’. This documentation would hopefully make it easier for other companies to follow.

6.1.3 The effects of temperature on driver sleepiness

It seems unknown in what amount temperature affects an individual’s experienced sleepiness level. As many drivers in this study mention colder temperatures as a way to counteract fatigue it would be interesting to see some research on the subject.

References

Agar, M., 1996. *The Professional Stranger: An Informal Introduction to Ethnography*. 2:a ed. s.l.:Emerald Group Publishing.

Anund, A., 2010. Perception of sleepiness before falling asleep [editorial]. *Sleep Medicine,* Issue 11, pp. 743-744.

Anund, A., Kecklund, G. & Peters, B., 2004. *Fatigued driving – drivers point of view*, s.l.: VTI rapport 498.

Anund, A., Kecklund, G., Peters, B. & Åkerstedt, T., 2008. Driver sleepiness and individual differences in preferences for countermeasures. *J. Sleep Res.* , Issue 17, pp. 16-22.

Anund, A., Åkerstedt, T. & Kecklund, G., 2011. *Sleepiness, crashes and the effectiveness of countermeasures - Consolidated report within ERANET node 15*, Linköping: VTI.

Borebély, A. A. & Achermann, P., 1999. Sleep Homeostasis and Models of Sleep Regulation. *J Biol Rhythms,* 14(6), pp. 559-570.

Dawson, D. & McCulloch, K., 2005. Managing Fatigue: It's about sleep. *Sleep Medicine Reviews,* Volume 9, pp. 365-380.

Dekker, S., 2009. Just culture: who gets to draw the line?. *Cogn Tech Work,* Issue 11, pp. 177-185.

Dekker, S., Sieghentaler, D. & Laursen, T., 2007. Six stages to the new view of human error. *Safety Science Monitor,* 11(1), pp. 1-5.

Di Milia, L. et al., 2011. Demographic factors, fatigue, and driving accidents: An examination of the published literature. *Accidents Analysis and Prevention,* Issue 43, pp. 516-532.

Ferrara, M. & De Gennaro, L., 2001. How much sleep do we need?. *Sleep Medicine Reviews,* 5(2), pp. 155-179.

Gander, P. et al., 2011. Fatigue risk management: Organizational factors at the regulatory and industry/company level. *Accident Analysis and Prevention,* Issue 43, pp. 573-590.

Graneheim, U. & Lundman, B., 2004. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, Issue 24, pp. 105-112.

Horne, J., 2010. Sleepiness as a need for sleep: When is enough, enough?. *Neuroscience and Biobehavioral Reviews,* Issue 34, pp. 108-118.

Horne, J. A. & Reyner, L. A., 1995. Sleep related vehicle accidents. *BMJ Vol 310,* pp. 565-567.

Horne, J. & Burley, C., 2010. We know when we are sleepy: Subjective versus objective measurements of moderate sleepiness in healthy adults. *Biological Psychology,* Issue 83, pp. 266-268.

Horne, J. & Reyner, L., 1999. Vehicle accidents related to sleep: a review. *Occup Environ Med ,* Issue 56, pp. 289-294.

Horrey, W. J. et al., 2011. Research needs and opportunities for reducing the adverse safety concequences of of fatigue. *Accident Analysis and Prevention,* Issue 43, pp. 591-594.

Kecklund, G. & Åkerstedt, T., 1993. Sleepiness in long distance truck driving: an ambulatory EEG study of night driving. *Ergonomics,* 36(9), pp. 1007-1017.

Linderholm, I., Hansson, J., Lindh, B. & Granstedt, K., 2008. *Lastbilsförarkulturer - Ökad säkerhet bland yrkesförare,* Lund: Trafikverket & Trivector Information.

Loh, S. et al., 2004. The vaidity of psychomotor vigilance tasks of less than 10-minute duration. *Behaviour Research Methods, Instruments & Computers,* Issue 36 (2), pp. 339-346.

May, J. F., 2011. Driver Fatigue. In: B. Porter, ed. *Handbook of traffic psychology.* 1:st ed. s.l.:Academic Press, pp. 287-297.

Mitler, M. M. et al., 1997. The sleep of long-haul truck drivers. *N Engl J Med.,* Issue 337(11), pp. 755-761.

Rabiee, F., 2004. Focus-group interview and data analysis. *Proceedings of the Nutrition Society ,* Volume 63, pp. 655-660.

Reason, J., 1998. Achieving a safe culture: Theory and practise. *Work & Stress,* 12(3), pp. 293-306.

Reason, J., 2000. Human error: models and management. *BMJ,* Volume 320, pp. 768-770.

Reason, J., 2000. Safety paradoxes and safety culture. *Injury Control and Safety Promotion,* Volume 7:1, pp. 3-14.

Sallinen, M. & Kecklund, G., 2010. Shift work, sleep, and sleepiness - Differences between shift schedules and systems. *Scand J Work Environl Health,* 36(2), pp. 121-133.

Shen, J., Barbera, J. & Shapiro, C. M., 2006. Distinguishing sleepiness and fatigue: Focus on definition and measurement. *Sleep Medicine Reviews,* Issue 10, pp. 63-76.

Thiffault, P. & Bergeron, J., 2003. Monotony of road environment and driver fatigue: A simulator study. *Accident Analysis and Prevention,* Issue 35, pp. 381-391.

Transportstyrelsen, 2011. *Kör och Vilotider: Regler och Vägledning Augusti 2011,* s.l.: Transportstyrelsen.

Wagstaff, S. W. & Sigstad Lie, J.-A., 2011. Shift and night work and long working hours - A systemativ review of safety implications. *Scand J Work Environ Health - Online first.,* Issue 37, pp. 173-185.

Van Dongen, H. P. A. & Dinges, D. F., 2000. Circadian Rythms in Fatigue, Alertness and Performance. *Principles and Practice of Sleep Medicine,* Issue 3rd Edition, pp. 391-399.

Williamson, A. et al., 2011. The link between fatigue and safety. *Accident Analysis and Prevention,* Issue 43, pp. 498-515.

Åkerstedt, T., 2003. Shift work and disturbed sleep/wakefullness. *Occupational Medicine ,* 53(2), pp. 89-94.

Åkerstedt, T. & Gillberg, M., 1990. Subjective and Objective Sleepiness in the Active Individual. *International Journal of Neuroscience,* Issue 52, pp. 29-37.

Åkerstedt, T. & Haraldsson, P.-O., 2001. Internationellt konsensusmöte om trötthet och olycksrisk i trafiken: Trötthet har underskattad betydelse för transportsäkerheten. *Läkartidningen,* 98(25), pp. 3014-3017.

Åkerstedt, T. & Kecklund, G., 2000. *Trötthet och Trafiksäkerhet - En översikt av kunskapsläget ,* Borlänge: Vägverket .

Åkerstedt, T. & Kecklund, G., 2001. Age, gender and early morning highway accidents. *J. Sleep Res. ,* Issue 10, pp. 105-110.

Appendix A – Interview Manual – Focus Group

Diskussionsgrupp: Trötthet i rollen som lastbilsförare: 2012-02-08

Inledning

Hej och välkomna till **VTI**!

Som ni redan vet så har vi ordnat den här fokusgruppen för att diskutera kring lastbilsförares arbetssituation med speciell fokus på trötthet. Tanken med den här diskussionsgruppen är att jag och Anna skall få mer kunskap om hur det är att vara lastbilsförare, hur ni tänker kring trötthet i ert arbete, om ni tror ni vet när det börjar bli farligt, hur ni hanterar trötttheten när ni märker att ni är trötta. Vi vill också förstå hur det är att leva som med lastbilsföraryrket och om andra saker utanför arbetet påverkar den trötthet ni upplever *i arbetet*. Med trötthet menar vi att man som förare måste anstränga sig för att hålla sig vaken och köra!

Min och Annas uppgift ikväll är att lyssna till er diskussion och lära oss av era erfarenheter. Vi vill att ni skall försöka glömma att vi sitter här och istället försöka att föra en diskussion kring trötthet med varandra. Vi kommer att lyssna och anteckna kring det ni har att säga. Det kan hända att vi någon gång sticker in med en fråga, men det kommer endast att ske i undantagsfall.

För att ha möjlighet att återkomma till den diskussion som förs här ikväll kommer vi spela in diskussionen. Era namn och andra personliga uppgifter kommer inte nämnas i den slutgiltiga studien, vi bryr oss inte om vem som säger vad eller något i den stilen utan vill bara försäkra oss om att vi tar tillvara på detta tillfälle på bästa möjliga sätt. Vi är här för att lära oss om era erfarenheter och tankar kring trötthet i er arbetssituation, så det är viktigt för oss att ni diskuterar utifrån *era egna* erfarenheter. Givetvis får ni ta del av den avslutande studien och det insamlade materialet om ni vill. Har ni några frågor?

Vi kan starta diskussionen med att kortfattat presentera oss själva och vad vi gör så att vi vet lite mer om varandra.

Jag heter Joel och läser sista terminen på kognitionsvetenskapliga programmet här på Liu och den här studien är mitt examensarbete. Förr så jobbade jag nattskift på en bilfabrik över somrarna och körde ofta de tre milen hem ensam efter att skiftet slutat. Så jag vet om hur det känns att vara trött bakom ratten och behövde ibland anstränga mig rejält för att hålla mig vaken och ibland också stanna och sova.

Jag heter Anna och även jag har jobbat natt, men på Saab.

Inledande frågor: Trötthet generellt

- Vi kan väl vara överens om att alla är trötta någon gång när de kör, när blir ni trötta?
- Hur vanligt tror ni att det är att lastbilsförare kör när de är trötta?
- Om vi börjar med att be alla ni som varit sömniga eller nästan somnat i samband med körning att räcka upp handen… berätta vad hade föregått det som hände?

Medvetenhet kring trötthet

- Hur tänker ni kring förekomsten av att köra när ni är trötta?
- När är det värst? Händer det på dagen?
- Planerar man innan nattskift för att minska risk för trötthet under natten/dagen?
- Om ni blir trötta när ni kör, vad gör ni då?
- Finns det situationer när ni är medvetna om att ni är trötta och fortsätter köra? Varför då?
- Finns det någon situation som upplevs som mer tröttande än andra? Vilken?
- Finns det möjlighet att stanna och sova i 15 minuter under ett pass om man känner sig trött?

Sociala faktorer

- Hur ser en typisk dag (arbete + fritid) ut för er? Vad innebär det att vara lastbilsförare?
- Hur är den allmänna inställningen till trötthet bland era kollegor?
- Om ni skulle säga att ”jag stannade och sov lite för jag var trött” till kollegorna, eller kunder för den delen, hur tror ni att det skulle tas emot?

Organisatoriska faktorer

- Vad har era chefer för inställning till trötthet i arbetet?
- Har ni fått direktiv/information från företaget/chefer kring hur ni skall hantera trötthet i relation till arbetet?
- Hur tycker ni att hela systemet kring färdskrivare och dygnsvila fungerar?
- Sker någon återkoppling till arbetsgivare kring trötthet i arbetet (Extra trött period, incidenter etc.)?
- Om ni fick välja vad tror ni då skulle vara det bästa sättet att minska körning när man är trött?

Appendix B – Driver Models

Relevant factors in relation to off-work and work situations	Time off work	Driving (early in the shift)	Loading cargo	Unloading cargo	Driving (Late in the shift)
Individual Goals	• Spend time with daughters. • Exercise • Photography	• Get to the location in time for load.	• Get cargo loaded as soon as possible.	• Get correct cargo off the truck and in the terminal.	• Get home and unload as soon as possible.
Organisational Factors	• Works two 14h shifts in a row. • Have a lot of spare time compensating for the limited spare time during the two work shifts. • Irregular work times during the week.	• Drives 85 km/h in order to make it comfortably down to the loading site. • 85 km/h is perfect match between economy and efficiency. • Always aware of the time.	• Have pre-sorted cargo waiting for him at the terminal. • Uses electric forklifts to load the truck.	• Uses electric forklifts to unload cargo.	• Puts tachograph in rest mode and takes 30 minute break later in order to get home faster. • Drives 85 km/h back as well.
Social Factors	• Lives 15 minutes from work.	• Occasional phone calls from other drivers. • Have no problems with the long times spent alone.	• Banters with personnel at the loading site.	• Not so much people around while unloading cargo.	• Occasional phone call and sporadic conversations at truck stops.
Environmental factors		• Hard to drive in bad weather. No chance to make it in time. • Uses cruise control. • Relax more now than when they began to drive the route.	• Colder temperatures in the storehouse.	• Colder temperatures in the storehouse.	• Uses cruise control. • Hard to drive in bad weather. No chance to make it in time.
Subjective Countermeasures	• Sleep as much as possible between these shifts.	• Drink coffee. • Listens to radio.	• Use forklifts • Have thicker clothes.	• Uses electric forklifts while unloading. • Have thicker clothes.	• Drinks coffee.
General Themes	This truck driver likes his job that's clear. He says that "driving isn't work I think. The way I see it I work 2.5 hours on a 14 hour shift". This driver likes to be alone and have a lot of spare time due to these 14h shifts. Interestingly this driver doesn't reflect as much on his tight schedule. The driver explains that 85 is the limit where police can start fine truck drivers, so this driver drives 85, but not faster. Also to me the passive pressure of making it in time is clear, as we see a truck overtake another truck rather slowly the driver says that "those minutes he gains from driving 5 km/h faster is what makes his trip inside the drive and rest regulations". The driver doesn't pond for long on the fact that the driver themself must pay the tickets if the police stops the truck. "That is how it is in this profession." The driver also describes problems in the winter where it's harder to keep the time. In that case one keep on driving, I write down the cause on the receipt and hopes that you get an understanding police officer." Thus, this driver is more likely to break the regulation and pay the tickets, rather than strictly follow the regulations.				
Truck Driver Culture	Work as a truck driver means a lot of freedom and a lot of responsibility. Take responsibility in the traffic and be the company's face towards the customers. Be service minded. Another thing that reoccurs from the focus group and other situated interviews is that there is an element of acceptance regarding small margins and putting themselves on the line when something goes wrong in these long routes. The fact that he feels so strongly for the driving part of the day is something i haven't encountered before. He clearly likes his work situation and has thought of driving longer distances as well.				

Relevant factors in relation to off-work and work situations	**Time off work**	**Driving early in the shift**	**Loading cargo**	**Unloading cargo**	**Driving late in the shift**
Individual Goals	• Sleep • Spend time with friends • Exercise • Household chores	• Get to first loading point in time. • Hopes for empty loading platform and "easy" cargo. • Starts planning for a possible second run. • Get to unload site as quick as possible.	• Get the truck and trailer loaded as quickly as possible in order to get ahead of schedule.	• Wants to find an electric forklift. • Unload cargo as quick as possible.	• Get home in time before the other driver begins work.
Organisational Factors	• Sleeps during daytime. • Works only night shifts.	• Tight working schedule. • Forced to break speed limit. • Describes pressure from supervisor. • Sometimes works double shifts (18-07.30).	• Physical work. Pulling cages on by hand. Tiring. • Instructions not to use forklifts as groceries can be damaged. • Nu forklifts to use.	• Always sets the tachograph in "rest-mode" while unloading. • Uses forklift to unload, when it is available.	• Need to drive without breaks in order to make the time schedule. • Pressure of not delaying the other driver. • Sometimes works double shifts (18-07.30).
Social Factors	• Misses out on social activities. • Commutes to and from work. • Adapt time off work to working schedule.	• Not much contact with other colleagues. • Occasional contact with other friends that still is awake.	• Not many opportunities to conversation with personnel at loading site.	• Some conversation with personnel, but depends on how much there is to do.	• Occasional contact with other colleagues also out driving.
Environmental factors	• Sleep during daytime. Often lighter.	• Monotonous driving environment. • Uses cruise control. • Increased fatigue if one can't relax. • Somewhat constant noise level.	• Cold temperatures. (4 / -25 degrees Celsius)	• Cold temperatures. (4 / -25 degrees Celsius)	• Monotonous driving environment. • Uses cruise control. • Increased fatigue if one can't relax. • Somewhat constant noise level.
Subjective Countermeasures	• If they feel that they have slept badly, they call the supervisor and explain that they might need to sleep during the night.		• Uses thicker clothes for work in cold temperatures. • "Nice to get out and move when one has been sat inside and driving. "	• Uses thicker clothes for work in cold temperatures.	• Sometimes talk with colleagues over the phone during the night shift. • Rolls down the window to reduce fatigue.
General Themes	Describes getting "brain dead" from this working shift. Not much thinking is needed to perform the work tasks. Later this driver describes having a bad conscience for calling in sick, because someone else (from the dayshift) must take her work shift. If this driver is pulled by the police and they find that they has driven over the speed limit, the driver will have to pay the speeding tickets, even if the company decides the route and the time the driver has to complete it. This driver is also relatively new in the profession and as a newcomer one might feel that you can't speak your mind in the same way that an established and more experienced colleague can. Also mentions tighter scheduling, that the route took 10 hours originally, but now it takes 8. "Have you pulled it off one time, then you can do it every time."				
Truck Driver Culture	There seems to be some hints that it's seen as somewhat shameful to ask for help and that work and that working as a truck driver is kind of a lonesome job. This driver may have encountered some of the "macho" traits early, as this driver's father and other family members also works as truck drivers. Also describes working a whole week with fever, and explains this with the difficulties in finding replacement drivers and mentality from the parents. Feel that male drivers think that she needs help "because she is a woman". This can possibly indicate that this driver feels some kind of extra pressure to perform, just *because* this driver is a woman. Is it so that truck drivers are supposed and thought of to handle themselves, strengthening the feeling of a free work environment? Also says that a truck driver "has to want to work, in order to be more liked by the company".				

Relevant fatigue and sleepiness related factors in relation to off-work and work situations	**Time off work**	**Driving (early in the shift)**	**Loading cargo**	**Unloading cargo**	**Driving (Late in the shift)**
Individual Goals	• Take care of papers • Household chores	• Knows some days before what and where they will be and what they will be doing. • Doesn't know if the daily plan will stay the same.	• Get close to cargo. • Very service minded. • Much planning.	• Get work done in time.	• Get home when work is done for the day.
Organisational Factors	• Has their own company which they also manage.	• Almost never exceeds the limit for drive and rest regulations. • Adapts their own schedule to the builders' schedule.	• Some physical activity, mostly climbing.	• Needs some timing in order to make the day as effective as possible.	• Rarely exceeds the limit for drive and rest regulations.
Social Factors	• Suffers from sleep apnea • Lives close to work.	• A LOT of phone calls • Plans forthcoming days as well as this day as they goes along.	• Banters with some people during the load of cargo.	• Much talk with people on the sites. • They describes that they have long relations with the companies that buys their service.	• Still much phone calls. • Planning further work.
Environmental factors	•	• Uses cruise control. • Says that they feel the effect of differences in temperature	• Can be tougher depending on weather conditions	• Can be tougher depending on weather conditions	• Uses cruise control. • Says that they feel the effect of differences in temperature
Individual Countermeasures	• Has a special sleeping position in bed when they sleep.	• Drinks coffee	• Uses thick clothes. • Have much experience and have routines to help remembering and stress less.	• Uses thick clothes. • Have much experience and have routines to help remembering and stress less.	• Drinks coffee
General aspects	Much of his experienced fatigue and sleepiness relates to the work tasks (as a crane truck driver) having more of a mentally demanding work rather than physical. This exemplifies in that this driver might drive for one hour a day, while craning windows for 6 hours in cold weather and then drive home again, which results in the driver being mentally rather than physically tired. Also describes the mentality regarding customer care. This driver and other companies work together to solve his customers' problems. If this driver can't help the customer they call another company and ask them to help the customer and this driver also receives work from other companies. The driver says that "one call from a customer should be enough". Doesn't have a mail address. Takes all work orders over the phone, which results in much planning. "Being a crane truck driver is somewhat like a taxi driver. The customers expect a service directly, something is needed to be moved from A to B."				
Culture	The driver says that being a truck driver is more than just a profession; it's a way of life. Seems to be someone who lives their life as a truck driver and describes how other relatives also have owned trucking companies and now their son owns one too. Likes the social aspects of the work and that work is very varied. Takes great pride in having returning customers.				

Relevant factors in relation to off-work and work situations	**Time off work**	**Driving (early in the shift)**	**Loading cargo**	**Unloading cargo**	**Driving (Late in the shift)**
Individual Goals	• Leave work at work • Play golf • Work with the house • Spend time at the summer home.	• Get to destination in time.	• Get certain types of cargo arranged according to temperature. • Get a forklift	• Be sure to drop off cargo at the right places. • Keep the forklift	• If everything is working out well, try to get home earlier.
Organisational Factors	•	• Have a time that they are supposed to be at the destination. No problems if they are a little late. • Easier if the truck is in good condition.	• Uses electric forklift while loading. • Helps other drivers to unload. • Need to control cargo in order to update the waybill.	• Uses electric forklift. • Gets help from other personnel at the sites.	• Should take breaks according to his schedule, but don't in order to get home faster. • Easier if the truck is in good condition.
Social Factors	• Work when most of the family are free, but says that it doesn't his social life in any great way.	• Talks with some colleagues and friends on the phone.	• Much interaction with colleagues during load. • Also some planning between drivers if someone's goods haven't arrived in time.	• Some interaction while unloading. • Some banter with personnel on the sites.	• Not so much interaction. Occasional phone calls.
Environmental factors	• Is able to keep roughly the same schedule on and off work.	• Uses cruise control. • Says that snowfall 'the white wall' is tiring.	• Colder temperatures while loading (4 / -25 degrees). • May have to wait for delayed	• Colder temperatures while loading (4 / -25 degrees).	• Uses cruise control. • Says that snowfall can be tiring.
Subjective Countermeasures		• Says that they seldom feel fatigued or sleepy during work hours. • Drinks coffee.	• Uses electric forklifts. • Have thicker clothes on while working in cold temperatures.	• Uses electric forklift. • Have thicker clothes on while working in cold temperatures.	• Drinks coffee.
General Themes	They seem open hearted and genuine when answering questions. On this route they seldom or never needs to take a break according to drive and rest regulations. Uses electrical forklifts while loading cargo and on this route personnel unload cargo on the destination. Uses thicker clothes while working in the colder storehouses. Seems to be very satisfied with the work tasks and the company in general. Feels that it's nice to be able to leave work behind and not be bothered during the spare time. Does make a clear distinction between work and spare time, which is a general theme during the observation. If the truck is serviced properly and so forth it makes a difference in the mentality. Service the truck is something that the driver and their colleagues work together with.				
Truck Driver Culture	Feels that it is hard to pin down if there is a specific culture among truck drivers. When they choose to mention something regarding the truck drivers in general it's more physical attributes rather than a way to be. When talking to the other drivers in the lunchroom the driver is more of a restricted type, not so much outspoken. Somehow to me it doesn't feel as they don't have the same "macho" mentality displayed by other drivers. Regarding what it means to be a truck driver the driver mentions that a truck driver shall show consideration to other traffic and drive "cleanly" meaning that one should stay inside the lines.				

Relevant factors in relation to off-work and work situations	Time off work	Driving early in the shift	Loading cargo	Unloading cargo	Driving late in the shift
Individual Goals	• Exercise • Sleep (relax from work)	• Get to the stops in time. • Have individual reference points to see if one is late or not. • Service minded	• Get the cargo on in the right order. • Load as quickly as possible.	• Get a preferable spot for unload. • Unload the cargo as quickly as possible.	• Get home for the last delivery. • Service Minded
Organisational Factors		• Irregular start times. (04 – 07.30) • Have guidelines for when to unload at the planned stops.	• Has electric forklift. • Cargo is pre-sorted and stands ready at the terminal. • A driver comes over to help load the truck because supervisors think that we are late.	• Unnecessary physical work. • Have an electric forklift. • "Strong boys" can unload quicker, describes influence on planning and scheduling. • Takes two charts at a time while walking. • Also brings back empty charts to the terminal.	• Different level of acceptance from supervisors regarding need to rest. • Takes the time to have a "proper" rest during this observation. • Harder to take a break if one knows that the truck shall be used directly after her shift ends.
Social Factors	• Have time to meet with family and friends. • Time for exercise • No commuting – can walk home in 20 minutes.	• Occasional phone calls from family members during the drive. • Longest drive today last 40-50 minutes.	• Helps and receive help from other drivers while at the home terminal.	• Much conversation with personnel at the different stops. • Seems to have a relation to personnel on this route.	• Not much interaction with other people during driving. • Longest drive today last 40-50 minutes.
Environmental factors		• Describes frustration regarding other road users as tiring. • Uses cruise control.	• Needs to return the collected charts from the route before being able to re-load the truck. • Can be forced to wait if there are drivers that unload before her.	• During winter the work gets more physical. • Have to walk some distance with cargo. • Not everywhere you could use the electric forklift. • Can adjust the height on the truck.	• Feels the fatigue on the highway, because one is done for the day "mentally". • Uses cruise control.
Subjective Countermeasures		• Better to have it cold in the drivers' cabin rather than warm. • Has a schedule for how the driver wants the truck to be loaded.	• Pre-sorted the charts beforehand. • Have a strategy for how to load the truck. • Uses electric forklift.	• Use electric forklift where you can.	• Drinks coffee
General themes	Describes the physical work as central during this shift. The single charts differ in weight from about 20-320 kg, so there is a significant factor of physical work and muscular fatigue. Also describes how being a female can be an advantage, because one is allowed to take time reversing into place, whereas a male truck driver can't because it isn't "macho". Also describes how one might get more help because she is a woman. Another interesting thing is the way this driver refers to "strong boys". I think of this as a passive pressure, in the way that this driver knows how much one is expected to handle, and that this driver feels that they somewhat lacks the physical ability to compete with the men in these situations. Says that it is a statement not to try to keep their tempo, because this driver is determined to not wear out her back or arms before retirement. When asked about being a woman in a very masculine profession the driver says that they had to prove themself to one's colleagues, "pull one's own weight". After that the driver received much help from colleagues.				
Truck Driver Culture	According to this driver, truck drivers working distribution must be socially competent, as they meet a lot of customers. Further describes it as a lonely as well as physically heavy profession. The driver describes that other drivers change the way they talk when they comes into a room. Another interesting thing is the way this driver refers to "strong boys". I think of this as a passive pressure to how much one is expected to handle, and that she feels that she somewhat lacks the physical ability to compete with the men in these situations.				

Relevant factors in relation to off-work and work situations	**Time off work**	**Driving (early in the shift)**	**Loading cargo**	**Unloading cargo**	**Driving (Late in the shift)**
Individual Goals	• Watch sports. • Be with family	• Get to the destinations in order to get home.	• Create loading plan according to which destinations he's going to.	• Be nice to customers. • Make sure that other drivers also are able to unload beside him.	• Get to the destination. • If possible, get home early.
Organisational Factors	• Work same set hours every week.	• Don't have any set times. • Describes a lot of flexibility on this route.	• Have a non-electric forklift he uses to load the cargo. • Have thick clothes provided by the company for work in colder conditions.	• Gets in the middle of policys and expected service. • Some physical work.	• Have a lot of flexibility. • Doesn't have any set times.
Social Factors	• Have time to spend with family.	• Occasional phone calls to and from family members during the early morning.	• Not much social interaction when loading cargo.	• Says that they sometimes do more than the company's getting paid for, just because they don't want to put up with the discussion. • Have a working relation with personnel on the destinations	• Occasional phone calls to and from family members during the early morning. • Also planning together with the company's traffic controller.
Environmental factors	• Have to commute for 25 minutes to and from work.	• Uses cruise control. • Feels that monotony can be tiring. • Snowfall also makes one sleepy, talks about the "white wall".	• Colder temperatures in the terminal. (4 / -25 degrees C) • Bad weather makes one even colder.	• Different temperatures on the destinations. • Differences in parking and accessibility.	• Uses cruise control. • Feels that monotony can be tiring. • Snowfall is also tiring, talks about the white wall.
Subjective Countermeasures	• Have bought a better bed in order to improve sleep quality.	• Counts the numbers on other cars number plates.	• Uses thicker clothes.	• Sometime does more than the agreement says. •	• Counts the numbers on other cars number plates.
General	This driver seems to be an easy-going person who doesn't feel much stress in their work. In his daily work this driver doesn't need to do any excessive physical work. This driver is very satisfied with the tasks, although they describe the discussions about the unloading conditions irritating and tiring. Says that the most exciting moment on the day is right at the beginning when he gets to see where one is going and while planning for the day. Says that they seldom feels sleepy, and that probably depends on the short drives and that much of the driving is off the highways. Says that they recognise that they recognise that they are tired when one is yawning more. Tries to sleep at least 6h a day. "Every day one wakes up and thinks that tonight I will go to bed early, but something always comes up. Kids homework, household chores, football or something else on TV."				
Culture	Says that the freedom and flexibility is the best bits about their job. Feels that they can do personal errands in the middle of the day if they just finish their work afterwards. Thinks that the company is great. Describes a good connection with supervisors who used to be truck drivers themselves. Describes responsibility just because the work is so free.				

Relevant factors in relation to off-work and work situations	Time off work	Driving at work (early in the shift)	Loading cargo	Unloading cargo	Driving at work (late in the shift)
Individual Goals	• Play sports • Sleep hours can depend on work shifts. • Household chores	• Get to first stop in time. • Starts planning in order to get home earlier.	• Eat and chats with colleagues. • Moves the truck in order to try to take 45 + 15 minutes rest.	• Eats and chats with colleagues. • Moves the truck in order to try to take 45 + 15 minutes rest.	• Get to destinations in time. • Plans in order to get home earlier. • Chooses roads depending on the weather and other circumstances. • Dangerous to think that one's work soon is finished.
Organisational Factors	• Sleeps during daytime	• Have certain time of arrivals at the different stops. • Have GPS tracking in the cargo. • If he is late to a destination they must fill in a mishap report. • One's own responsibility to stay alert and well rested.	• If ones cargo is late, margins tighten for the rest of the night. • Gets a receipt in order to know in which terminals he should unload and load. • Workers also load the truck for the driver.	• Just have to leave the cargo at the gate, and the workers at the site unload it.	• Have certain time of arrivals at the different stops. • Have GPS tracking in the cargo. • If he is late to a destination they must fill in a mishap report. • One's own responsibility to stay alert and well rested.
Social Factors	• Grown up children and a partner that travels a lot in their profession. • Says that working night shifts doesn't have any negative consequence regarding their family life.	• Talks in phone.	• Have lot of time to sit and talk with colleagues and other workers at the destinations.	• Have lot of time to sit and talk with colleagues and other workers at the destinations.	• Talks a lot in phone with other drivers. Have some friends which they normally call.
Environmental factors	• Sleep during daytime. Often lighter.	• More tiring if one is stressed over bad weather. • Truck is limited to 80 km/h. • Uses cruise control. • Has a bed in the cabin.	• Loading time may depend on other drivers and if they are late.		• More tiring if one is stressed over bad weather. • Has a bed in the cabin.
Subjective Countermeasures	• Adjusts sleep time depending on how tough his upcoming work shift is.	• Talks in phone • Drinks coffee. • Able to relax as they can't drive faster than 80 km/h. • Sleep			• Talks a lot in phone. • "Fiddle with something". (Eats cucumber or carrot.) • Count posts along the roadside. • Listen to radio. • Drinks coffee. • Sleep
General Themes	Seems very open hearted when he describes his work situation. Even though this driver has many years of routine from the night shift, also seems to have a planning approach to their work. Among other things this driver says that they can manage some routes on 4 hours of sleep and other routes (such as this one) they need 7 hours of sleep. Also says that "one never sleeps as good as when you're getting paid for it", which initially I thought to believe that they felt no negative pressure from the company if they would take naps during the work shift, but I came to believe that this statement also (or rather) reflected an intent to get home and in bed before one's working shift had finished, time wise. This is shown in their planning of the route from the start, which includes taking a tactical 15 minute break in order to get home quicker. This intent to get home also reflects itself in the following statement: "If I'm tired when I leave from my last stop (40 minute drive from home) I'll keep on going because I'm that close to home." Also describes a kind of "distance" within the company, as one often can get new directives where it's clear that the people administrating these directives doesn't know how it is to drive the route. According to the driver the same distance is present when buying new trucks. Instead of asking the truck drivers what in the truck cabin that matters for them, the company can decide to save 700 sek on an arm rest, when this armrest makes a big difference in convenience for the drivers.				
Truck Driver Culture	One of the most interesting things during the night was that the driver felt that they wouldn't say they an accident because of fatigue or sleepiness; instead the driver would rather say that they turned for an animal. When asked why, they answered that it is their own responsibility to stay alert and well rested. The driver also experiences that it is the truck drivers that often are caught in the middle if something happens, this describing a somewhat ungrateful working situation described by many truck drivers in this study. The driver also says that the truck driver profession is a bit masculine, but doesn't expand much on the subject. The conversations with other truck drivers are to me very virile or "laddish". When asked what it means to be a truck driver, the driver says that it's a very free working environment as well as lonely. This driver also thinks that it is a big responsibility to drive such a large vehicle.				

Relevant factors in relation to off-work and work situations	**Time off work**	**Driving (early in the shift)**	**Loading cargo**	**Unloading cargo**	**Driving (Late in the shift)**
Individual Goals	• Sports • Gardening	• Get to the destination as soon as possible.	• Pre-sort cargo in order to make unload easier.	• Be nice to customers and provide a good service. • Get the load of nice and easy	• Get back after the route is finished.
Organisational Factors	• Suspicion of work related injuries. (shoulder)	• Have no fixed loading times • If one gets late it is always possible to phone and change times.	• Have a rail system to use when loading meat onto the truck. • Physical effort when pushing the meat onto the truck.	• Uses the rail system to unload.	• During this shift they take appropriate rest according to drive and rest regulations.
Social Factors	• Have time to spend with family and other social activities. • Says that their injured shoulder have a negative effect on their sleep. • Sleeps about 4-5 hours a night.	• Occasional phone calls during the early drive.	• Some interaction with workers during the loading phase. • Greets some personnel at the destinations.	• Have a work relation to many of the customers. • Some banter at certain destinations.	• Occasional phone calls.
Environmental factors	• Lives relatively close to work	• Uses cruise control. • More stressful when driving in slippery conditions.	• Bad hooks grind the rail and makes work harder. • Have a downhill fall when loading, which improves the working situation.	• Rail can be old and poorly maintained, therefore unload can be physically tougher. • Height difference also have an impact as it makes work more physically demanding. • Other environmental factors such as weather also have an impact.	• Uses cruise control. • More stressful when driving in slippery conditions.
Subjective Countermeasures		• Keep a convenient temperature in the cabin. • Sing along to music if one feels tired.	• Have own practices planning and loading in order to make it as easy as possible. Take 4 pigs at once and so on.	• Talks about an intention to maintain and repair some of the unloading rails themself.	• Have a sleep break on this route. • Listens to radio.
General Themes	During this this observation, to me the fatigue related factors that has the most impact on this particular working shift are more linked to physical labour than long driving times. In order to load and unload cargo it takes a significant amount of physical labour. Describes a worn-out shoulder as a result from having to push the hooked meat on and off the truck for so long. He also describes that this has an effect on their sleep. Claims to be more of a stubborn self-healer, as they at first didn't want to seek medical attention about their shoulder, but now the driver finally has seen a doctor about his problem. Also describes themself as hot-tempered and tells several anecdotes about how they has been angry at other drivers and gone after them in order to discuss or tell someone that they've done wrong. During the observation, the driver also drives really close to a car that doesn't keep an even pace on the road in order to "teach them a lesson". Has a regular sleeping break on the route and the company also have a policy to take a driver off work if he has worked 40 hours during the week, replacing the driver with a driver that is employed by the hour. Mentions that there have been occasions when they have cheated with drive and rest regulations.				
Truck Driver Culture	Doesn't know if there exists such a thing as a truck driver culture, but says that truck drivers help each other and that traffic safety is important. As many other truck drivers I've spoken to this driver values the individuality and freedom that comes with the profession. When discussing problems in their profession my interpretation is that the driver doesn't seem fully aware of how different aspects in their work affect the driver and what the driver can do to counteract these factors. For instance they doesn't mention a different kind of loading technique, even though the driver themself points out that this possibly is the cause of their worn-out shoulder. This driver gets his work done, even if they have to carry the cargo by hand for half a year, as they describe doing at one of our destinations.				

APPENDIX C- KSS

vti

2012-02-16

Namn: _____

Datum: _____

KSS skalan

1 – extremt pigg
2 – mycket pigg
3 – pigg
4 – ganska pigg
5 – varken pigg eller sömnig
6 – första tecknen på sömnighet - lätt sömnig
7 – sömnig men ej ansträngande vara vaken
8 – sömnig och något ansträngande att vara vaken
9 – mycket sömnig, mycket ansträngande att vara vaken, kämpar mot sömnen

Markera den tid du arbetat, sovit och ätit under det senaste dygnet. Under de tider som du arbetar vill vi be dig att en gång varje timme skatta hur din vakenhet varit under timmen som gått. Detta gör du med KSS skalan. →

Klockslag	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	07
Arbete																								
Sömn																								
Mat																								
Kaffe/Te																								
Medicin																								
KSS under körning																								

Appendix D – Interview Manual - Company Representatives

Intervjumall

Syftet med intervjun är att få ett organisationsperspektiv på lastbilsförarnas arbetsmiljö för att skapa ett helhetsintryck. Jag kommer också ställa lite frågor kring företagets perspektiv på verksamheten, samt hur ni tänker kring förartrötthet. För att ha möjlighet att återkomma till samtalet senare så kommer intervjun att spelas in. Det är viktigt att poängtera att det inte finns något intresse i att kontrollera verksamheten, utan syftet är att beskriva hur trötthetsläget är idag. Frågorna har sin grund i 8 observationer genomförda på åkerier runt om i Östergötland och en fokusgrupp med frivilliga förare genomförd på VTI.

Du får när som helst avbryta samtalet om du känner för det. Alla svar kommer att anonymiseras i den slutgiltiga uppsatsen och du får också tillgång till uppsatsen efter att studien är klar om du så vill. Har du några övriga frågor?

Inledande frågor

- Namn
- Ålder
- Position och ansvar
- Erfarenhet

Rutter & schema

- Hur går det till när åkeriet får en ny linje att köra? (Nytt kontrakt?)
    - Vilka faktorer spelar störst roll vid planering av ett körschema för en speciell bil?
        - Hur läggs förarschemat?
    - Planerar ni raster och när de skall tas?
        - Pendlande förare?
    - Hur tillsätts en förare (hierarki, erfarenhet, nyanställning, kommer med linjen)?
    - Hur mycket koll har du på hur föraren har det privat?
- Förändras hålltider på fasta rutter? Om ja, Vad påverkar en sådan förändring?
- Vilken möjlighet har förarna att påverka valet av utrustning/schema/rutter att köra?
- Hur stor kunskap skulle ni säga att ni har om kraven som ställs på förarna under arbetspassen?
- Sker det någon dialog med förarna angående schema och arbetsuppgifter?

Ansvar & regler

- Vad ansvarar beställare (kunden) för? (Gods, hjälpmedel, fungerande portar etc.)
    - Lastbryggor?
    - Pallyftar & Truckar?
- Vad ansvarar åkeriet för? (Hjälpmedel, gods, fungerande bilar etc.)
    - Pallyftar och truckar?
- Vad ansvarar förarna för? (leveranser, gods, fungerande bilar etc.)

    - Böter för fortkörning & KoV? Hur ser det ut ur ett åkeriperspektiv? Får åkeriet också böter?
- Om man tänker övergripande kring ett arbetspass, var skulle ni säga att ert ansvar slutar och en förares börjar? Kan man göra en sådan uppdelning?

Trötthet

- Upplever ni att era förare är trötta?
- Är trötthet hos förare något ni pratar om ?
- Tror du att förarna skulle vända sig till dig om de hade problem i frågan?
- Har ni haft några incidenter som är trötthetsrelaterade?
    - Får man fråga om antalet olyckor per år i åkeriet?
- Vilket ansvar anser ni att åkeriet har när det gäller trötthetsinformation och förarnas hantering av trötthet?
    - Vidtagit några åtgärder i trötthetsfrågan? (Undersökt problemet, samla in ”rapporter” från förare?)
- Hur tror ni att era anställda skulle beskriva åkeriets inställning till trötthet?

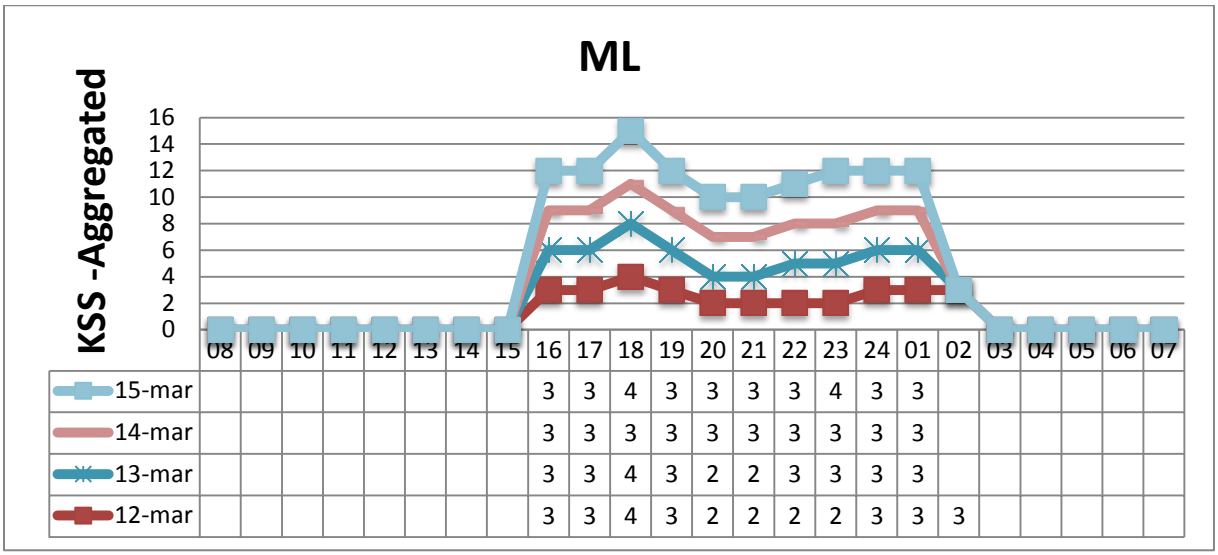
Avslutande

Tack så mycket!

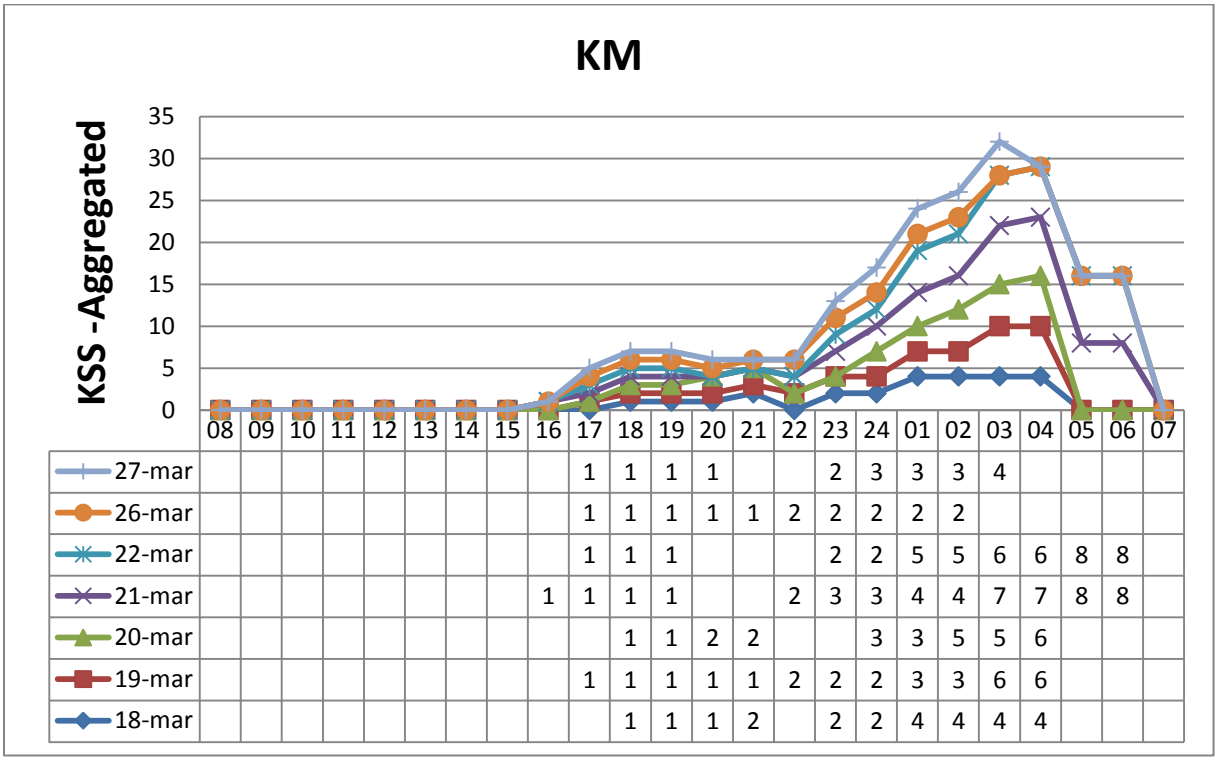
Har du några ytterligare frågor?

Om du har några ytterligare frågor eller vill få en kopia av uppsatsen kan du alltid nå mig på joel.johansson@vti.se eller 013-20 42 16.

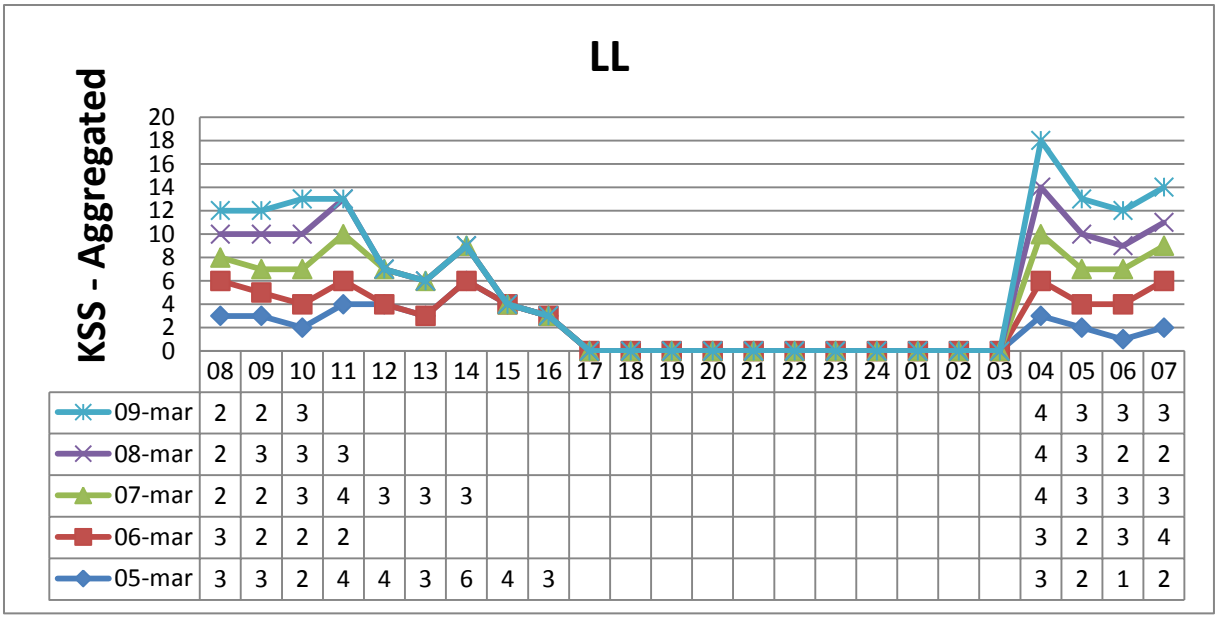
APPENDIX E – Self-stated KSS-Levels from each driver



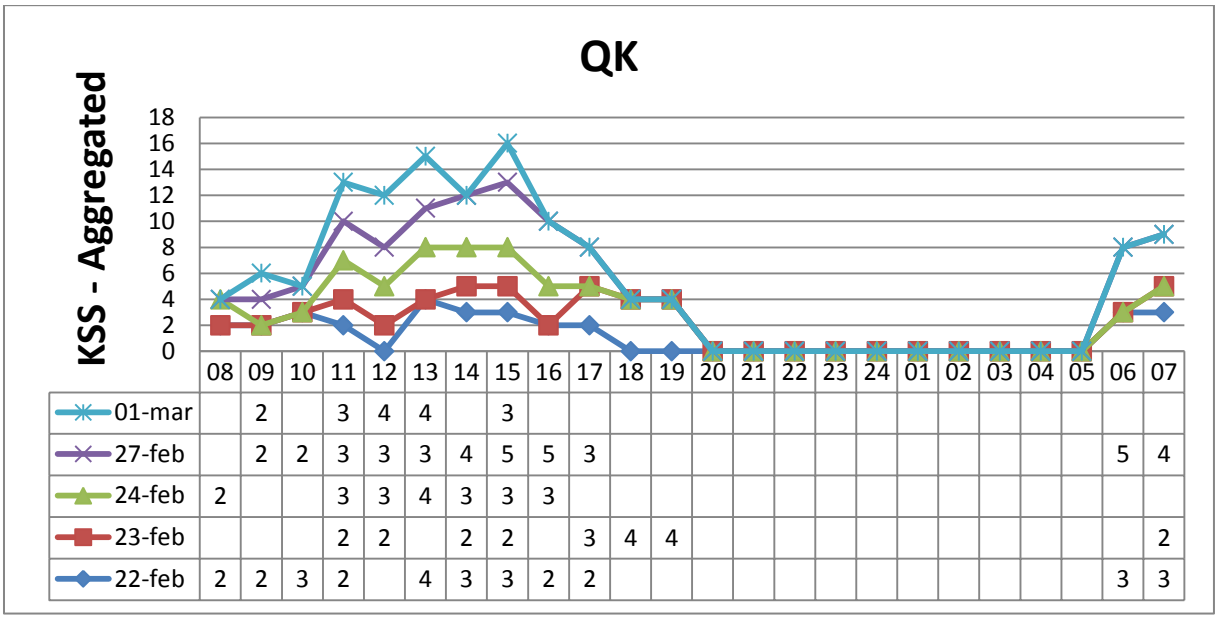
	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	07
15-mar									3	3	4	3	3	3	3	4	3	3						
14-mar									3	3	3	3	3	3	3	3	3	3						
13-mar									3	3	4	3	2	2	3	3	3	3						
12-mar									3	3	4	3	2	2	2	2	3	3	3					



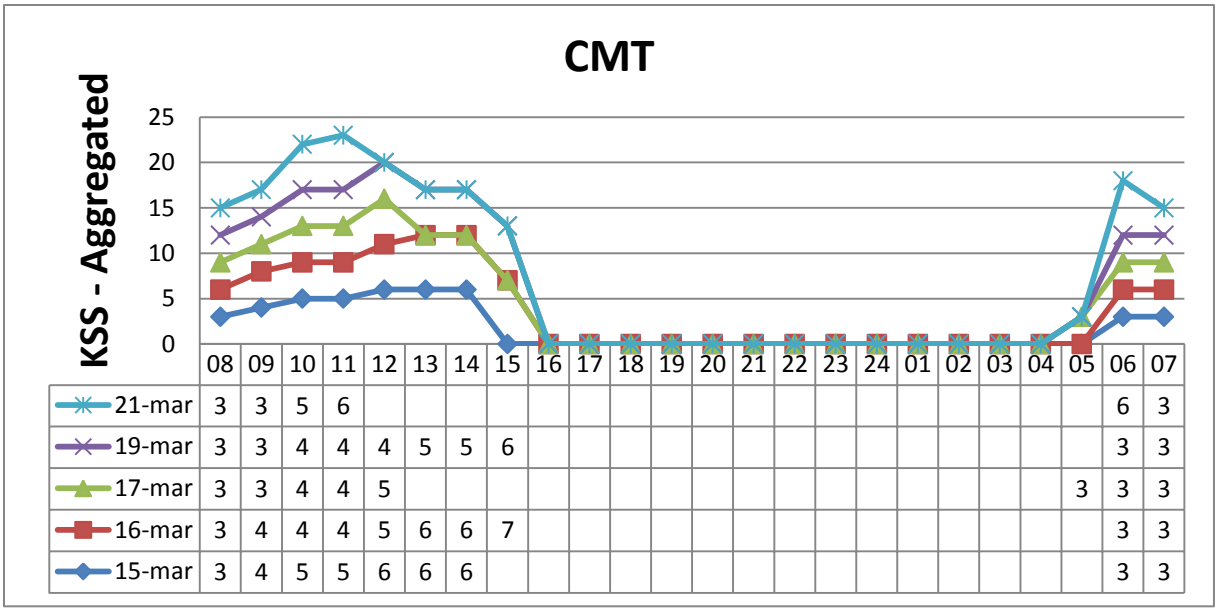
	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	07
27-mar										1	1	1	1			2	3	3	3	4				
26-mar										1	1	1	1	1	2	2	2	2	2					
22-mar										1	1	1				2	2	5	5	6	6	8	8	
21-mar									1	1	1	1			2	3	3	4	4	7	7	8	8	
20-mar											1	1	2	2			3	3	5	5	6			
19-mar										1	1	1	1	1	2	2	2	3	3	6	6			
18-mar											1	1	1	2		2	2	4	4	4	4			



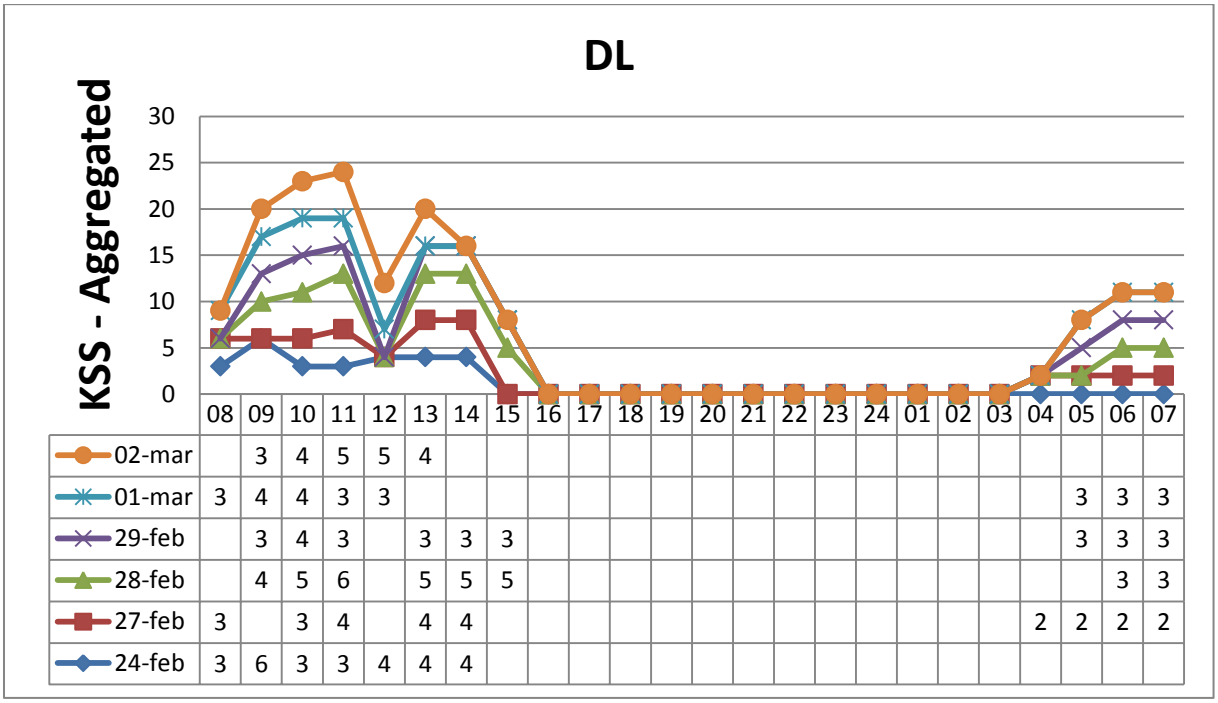
	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	07
09-mar	2	2	3																		4	3	3	3
08-mar	2	3	3	3																	4	3	2	2
07-mar	2	2	3	4	3	3	3														4	3	3	3
06-mar	3	2	2	2																	3	2	3	4
05-mar	3	3	2	4	4	3	6	4	3												3	2	1	2



	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	07
01-mar		2		3	4	4		3																
27-feb		2	2	3	3	3	4	5	5	3													5	4
24-feb	2			3	3	4	3	3	3															
23-feb				2	2		2	2		3	4	4												2
22-feb	2	2	3	2		4	3	3	2	2													3	3



	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	07
21-mar	3	3	5	6																			6	3
19-mar	3	3	4	4	4	5	5	6															3	3
17-mar	3	3	4	4	5																	3	3	3
16-mar	3	4	4	4	5	6	6	7															3	3
15-mar	3	4	5	5	6	6	6																3	3



	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	07
02-mar		3	4	5	5	4																		
01-mar	3	4	4	3	3																	3	3	3
29-feb		3	4	3		3	3	3														3	3	3
28-feb		4	5	6		5	5	5															3	3
27-feb	3		3	4		4	4														2	2	2	2
24-feb	3	6	3	3	4	4	4																	

www.vti.se
vti@vti.se

VTI är ett oberoende och internationellt framstående forskningsinstitut som arbetar med forskning och utveckling inom transportsektorn. Vi arbetar med samtliga trafikslag och kärnkompetensen finns inom områdena säkerhet, ekonomi, miljö, trafik- och transportanalys, beteende och samspel mellan människa-fordon-transportsystem samt inom vägkonstruktion, drift och underhåll. VTI är världsledande inom ett flertal områden, till exempel simulatorteknik. VTI har tjänster som sträcker sig från förstudier, oberoende kvalificerade utredningar och expertutlåtanden till projektledning samt forskning och utveckling. Vår tekniska utrustning består bland annat av körsimulatorer för väg- och järnvägstrafik, väglaboratorium, däckprovnings-anläggning, krockbanor och mycket mer. Vi kan även erbjuda ett brett utbud av kurser och seminarier inom transportområdet.

VTI is an independent, internationally outstanding research institute which is engaged on research and development in the transport sector. Our work covers all modes, and our core competence is in the fields of safety, economy, environment, traffic and transport analysis, behaviour and the man-vehicle-transport system interaction, and in road design, operation and maintenance. VTI is a world leader in several areas, for instance in simulator technology. VTI provides services ranging from preliminary studies, highlevel independent investigations and expert statements to project management, research and development. Our technical equipment includes driving simulators for road and rail traffic, a road laboratory, a tyre testing facility, crash tracks and a lot more. We can also offer a broad selection of courses and seminars in the field of transport.

vti

HUVUDKONTOR/HEAD OFFICE
LINKÖPING
POST/MAIL SE-581 95 LINKÖPING
TEL +46(0)13 20 40 00
www.vti.se

BORLÄNGE
POST/MAIL BOX 920
SE-781 29 BORLÄNGE
TEL +46 (0)243 446 860

STOCKHOLM
POST/MAIL BOX 55685
SE-102 15 STOCKHOLM
TEL +46 (0)8 555 770 20

GÖTEBORG
POST/MAIL BOX 8072
SE-402 78 GÖTEBORG
TEL +46 (0)31 750 26 00