

DRIVER FATIGUE IN EUROPEAN ROAD TRANSPORT

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ETF is a pan-European trade union organisation representing more than 5 million transport workers in over 30 countries., in the following sectors: railways, road transport and logistics, maritime transport, inland waterways, civil aviation, ports and docks, tourism and fisheries.



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SUMMARY

Driver fatigue is widely recognised as a major risk factor that reduces road safety and poses a threat, not only to drivers, but to all road users. However, there has been little research on driver fatigue in commercial transport, and no extensive EU-wide study or report on the topic in the last 15 years.

The twofold objective of this study is, firstly, to describe the nature and extent of driver fatigue in the road passenger and freight transport sector in Europe. Secondly, it sets out to examine the specific working conditions of professional drivers and how these conditions lead to endemic fatigue in the sector. Very few studies have analysed fatigue in bus, coach and truck drivers in the context of their specific work environment and working conditions or the general economic conditions of the sector.

The study has reviewed the existing literature on the relation between safety and causes and countermeasures affecting fatigue in bus, coach and truck drivers.

It is based on an analysis of primary data gathered through an online survey of around 2,800 bus, coach and truck drivers in Europe, as well as in-depth interviews and workshops involving drivers, trade union representatives and scientific experts.

Experiencing fatigue is not a conscious or planned decision; it is rather an autonomic mental and physical process

DEFINING DRIVER FATIGUE

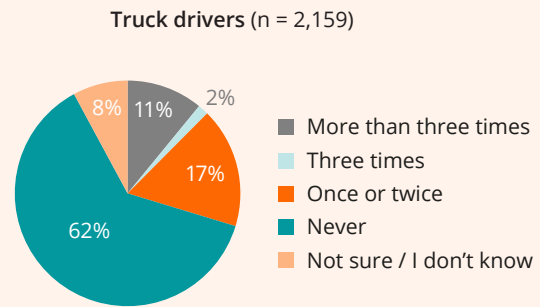
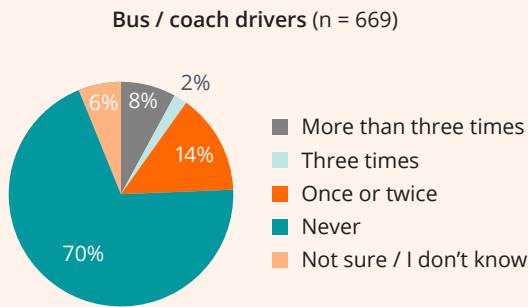
Because fatigue is defined in various ways, some drivers do not know its symptoms and may not even be aware that they are fatigued until an accident occurs. However, many definitions share the idea that fatigue is a state caused by prolonged exertion. It is a condition that manifests itself physiologically, cognitively and emotionally. In drivers, it leads to a decrease in mental and physical functioning, which in turn leads to poor steering control, decreased reaction time, poor speed tracking and loss of attention and hazard perception. Experiencing fatigue is not a conscious or planned decision; it is rather an autonomic mental and physical process

Road accidents involving heavy vehicles tend to be more serious than other collisions

Fatigue-related crashes are often characterised by a significant loss of control that results in an unintended vehicle trajectory, and no braking response. Road accidents involving heavy vehicles tend to be more serious than other collisions, with grave consequences for all concerned, because the vehicles' size and mass entail greater and more destructive forces. In Europe in 2016 (according to the latest available data, from the EU CARE database) 4,002 people were killed in road accidents involving trucks, and 594 people in accidents involving buses or coaches.

An exhaustive list of the symptoms of driver fatigue may not be universally agreed, but it is

In the past 12 months, how often have you fallen asleep while driving?



widely understood among bus, coach and truck drivers that driver fatigue is a serious problem throughout Europe. Many drivers see fatigue as a characteristic feature of the driving profession.

60% OF DRIVERS ARE FATIGUED WHILE DRIVING

The survey's results show that around two-thirds of professional drivers regularly feel tired when driving (66% of surveyed bus and coach drivers; 60% of surveyed truck drivers). Around a quarter to almost a third of drivers admitted to having fallen asleep while driving at least once in the previous twelve months (24% of the bus and coach drivers; 30% of the truck drivers). However, our targeted interviews also show that drivers are generally afraid of reporting such incidents, as they fear it might have repercussions on their employment. The real extent of the problem could potentially be much greater.

Despite the recognition of fatigue as a risk factor for accidents, and despite the existence of legislation at European level on driving times and rest periods, this study shows that driver fatigue is a widespread and structural problem in the road passenger and freight transport sector in Europe.

POOR WORKING CONDITIONS ARE THE CAUSE

While there is a wide variety of possible reasons for driver fatigue, existing studies focus only on a handful. Factors often cited in studies include lack of sleep, poor quality sleep and specific sleep demands. This study, however, goes a step further, and shows how poor working and employment

conditions are among the underlying reasons accounting for shortage of sleep in the first place.

Long working hours

A key contributor to fatigue is the total extent of working time. The working hours of bus, coach and truck drivers are particularly long, leaving insufficient time for satisfying the basic needs for recuperation and restorative sleep, let alone for the achievement of a satisfactory work-life balance.

88% of the surveyed truck drivers and 60% of the surveyed bus and coach drivers worked more than the 40 hours per week – which is considered the norm in most other sectors and professions – and a significant proportion of these drivers worked more than 50 hours per week.

Around a quarter to almost a third of drivers admitted to having fallen asleep while driving at least once in the previous twelve months

Low salaries

There is a direct relation between the level of drivers' remuneration and their long working hours. A common proposal by the surveyed drivers was that working time should be reduced in order to reduce driver fatigue. However, drivers also remarked that reduced working time would require an increase in wages, which typically involve extremely low hourly rates.

Having to work during breaks

Bus, coach and truck drivers often report having to use their breaks for activities that constitute “other work” (as defined in the EU legislation governing the sector): tasks such as finding parking spaces, supervising loading and unloading activities or loading and unloading passenger luggage, helping passengers to board, and in other ways, interacting with dispatchers or clients, and studying the route. As a result, drivers very often simply skip breaks, although they are often instructed by employers to register time spent on these activities as break time.

Interrupted rest and sleep

The low quality of the rest that drivers get is also a serious problem. Sleep quality is often reduced by interruptions and unfavourable sleeping conditions. The EU’s “ferry/train derogation” allows an employer to count the time a driver spends travelling by ferry or train as a rest period. However, such supposed rest periods, and drivers’ opportunities to sleep, are typically disrupted by the processes of embarking and disembarking and other interruptions. The ferry/train derogation can only be used lawfully when the driver has access to a bunk bed or couchette; however, a grievance highlighted by drivers participating in our research was that they often lack appropriate rest facilities during such journeys.

Unpredictable working conditions

Many drivers taking part in our survey reported irregular and unrealistic working schedules, rotating shifts with frequent changes in the work-rest schedule, round-the-clock schedules and night work, all of which conflict with the human body’s circadian rhythms and lead to irregular sleep patterns and stress.

Health and safety

Drivers also reported having to work in harsh and uncomfortable environmental conditions that contribute to fatigue – conditions affected by, for example, heat, cold, noise and mechanical vibration inside the vehicle, as well as external factors such as bad weather, poor visibility, poor roads

and high-density traffic. Heat poses a particular problem, since air conditioning in the vehicles is often inadequate, and fails to regulate the temperature well. In the case of truck drivers, sleep in the cab is commonly disturbed by the lack of air conditioning, unshielded noisy motorways and fear of robberies, owing to a shortage of secure parking areas.

SOLUTIONS: POINTS FOR EMPLOYERS AND LEGISLATORS

Our survey results show that, when circumstances permit, drivers often end up resorting to “self-administered” measures to counter fatigue, such as stopping and taking a nap.

However, tight delivery schedules and a structural shortage of adequate parking areas across Europe prevent

truck drivers in using such measures on a regular basis. It should also be emphasised that bus and coach drivers are not free to take a break or nap whenever

they need to, as they have passengers on board and strict time schedules to follow. In any case, the prevention of driver fatigue cannot and should not be reduced to a task for the individual driver.

The road transport sector has been characterised by deregulation and intensifying competition, with increasing demand for inexpensive, flexible, fast and on-time transport. This has put excessive pressure on drivers, and degraded their employment and working conditions. Because these conditions are determined by the development of the market, the control over the fundamental causes of driver fatigue lies primarily with employers and legislators.

Employers

Our study sets out a number of countermeasures that employers can implement to help eliminate driver fatigue. These include Fatigue Risk Management strategies at the company level,

The prevention of driver fatigue cannot and should not be reduced to a task for the individual driver

investment in better equipment for vehicles (for example, good air-conditioning), and a reduction in physical labour for drivers – since physically demanding work also leads to fatigue.

Particularly important countermeasures identified by this study are a reduction in working time (while compensating any negative effects this might otherwise have on a driver's pay), and improved recording of working time. Our data analysis shows a correlation between poor documentation of working time and driver fatigue. In companies that rigorously document working hours, drivers are less affected by fatigue. But drivers are frequently instructed to register working time as break or rest time. This affects not only the wellbeing of the drivers, but also their pay. And it ultimately affects road safety. Employers therefore need to ensure that all work-related tasks are counted towards working time and are properly recorded – and paid for – as such.

Legislators

Legislators have the power to remedy aspects of driver fatigue that are consequences of deregulation and strong competition in the sector. EU directives and regulations already impose requirements governing working time, driving hours, breaks and rest periods for bus, coach and truck drivers. However, the existing regulatory

framework does not seem to be solving the problem of driver fatigue, or reducing its impact on road safety, effectively enough. Hence the call by drivers participating in our study to tighten up the rules. As for the “ferry/train derogation”, drivers taking part in our research recommended that it should be scrapped completely.

Another problem with the existing regulatory framework is that it is neither consistently nor effectively enforced. Besides strengthening regulations, a key countermeasure in fighting fatigue is therefore to strengthen enforcement of the existing rules through checks and sanctions. Accountability is generally a problem if there are no checks and sanctions, or if the gains that can be made from infringements are greater than the penalties for non-compliance. The transport sector is no exception in this respect. Instead of pushing for even more deregulation, this is where future action to combat driver fatigue in the EU should start.

The control over the fundamental causes of driver fatigue lies primarily with employers and legislators



1

INTRODUCTION

Driver fatigue is a major concern among bus, coach and truck drivers and the risk it brings to the safety of all road users is widely evident across the road transport sector in Europe. Despite the gravity of the issue, attempts to tackle it have been limited.

Very few studies have been published so far on the topic of driver fatigue. There is little on driver fatigue in commercial transport and there has been no extensive EU-wide study or report on the topic in recent years. Existing studies on the topic are rather fragmented, and mainly focus on consequences rather than on causes of driver fatigue. Furthermore, most literature on professional driver fatigue refers to truck drivers, while fatigue in bus and coach drivers has so far received hardly any attention.

Driver fatigue, including sleepiness, causes psychological and physical impairment, which leads to a reduction in performance and can adversely affect the health of drivers in the longer term. The reduction in performance is not the result of a conscious or planned decision but is rather an autonomic mental process, which the fatigued person may not be aware of. Symptoms of fatigue generally include a loss of alertness, an increase in reaction time, distorted judgement, memory lapses, and the reduction of a driver's field of vision. The most dangerous symptom of driver fatigue – falling asleep at the wheel – negates the driver's ability to operate the vehicle.

Several studies show that fatigued drivers are more likely to be involved in accidents and that fatigue is a significant causal factor in road traffic accidents. As driver fatigue leads to a

deterioration of driving performance manifested in slower reaction time or a significant loss of control, fatigue-related crashes are often serious, and more likely to result in fatalities. However, determining the actual proportion of accidents that result from driver fatigue is difficult. Studies that have attempted to do so have used different research methods, and most such studies date back several years. Although estimates of the contribution of fatigue to road crashes vary from one study to another, it is understood that the problem of driver fatigue is significant and tends to be under-reported in most crash databases.

Due to various factors, professional drivers constitute a group of road users with a heightened risk of driver fatigue. Even though there are difficulties in profiling driver fatigue and assessing its true prevalence, it is clear that fatigue among drivers of trucks, buses and coaches is very widespread, and a serious problem throughout Europe.

The issue is complex and multifaceted. There is a wide variety of possible underlying reasons for driver fatigue, and fatigue can often be considered to be the result of a complex interplay between factors.

The existing literature divides causes of fatigue into categories, such as individual factors (for example, a driver's sleep and health); driving- and task-related factors (such as monotony of the road, availability of rest areas, heat, noise and vibration) and employment- and working-condition-related factors (such as working hours and task demands). Interestingly, most research on driver fatigue focuses on sleep-

related factors, followed by driving- and task-related factors. Employment-condition-related causes have, by contrast, attracted little attention so far. This is particularly noteworthy, since our research shows that many factors that have previously been regarded as sleep-, health- or task-related are actually effects of poor working conditions, and that these play a major role in determining driver fatigue. Our research identifies long working hours, infrequent and insufficient rest breaks, unpredictable and irregular working hours, and pressing delivery or tour schedules as the main causes of fatigue in bus, coach and truck drivers. The liberalisation of the road freight and passenger transport market, and increasing price competition, have led to a further deterioration in conditions that were already very poor.

The countermeasures for tackling driver fatigue that have been considered in desk research are as diverse as the causes of fatigue. Such measures can be categorised as self-administered measures, management interventions, road infrastructure measures, legislation and enforcement, fatigue-detection technology and publicity campaigns. However, efforts to reduce fatigue and fatigue-related crashes require a better understanding than we have previously had of the causes of fatigue. For example, when, in considering effective countermeasures, one focuses on the source of fatigue, it becomes evident that mental and physiological underload and overload require completely opposite countermeasures. In addition, we find that work-related fatigue can be best managed at an organisational level, while non-work-related factors vary considerably between individuals and are best managed at an individual level. Our study clearly shows that measures to prevent driver fatigue need to focus primarily on the improvement of employment and working conditions for bus, coach and truck drivers. It is interesting to note that, in the research conducted so far, very little has been done to evaluate the proposed measures for reducing driver fatigue.

As part of the EU-financed project “Trade unions and drivers for safer roads in Europe”, the European Transport Workers’ Federation (ETF)

has commissioned this study in order to gain a better understanding of the extent and nature of fatigue in bus, coach and truck drivers, and to investigate its causes.¹ The project also aimed to identify actions to counter driver fatigue and to help prevent the serious consequences it has for drivers themselves and for road safety in general. This study examines aspects of fatigue in professional drivers working across the passenger and freight transport sectors. With regard to bus and coach drivers, the project focuses on interurban and cross-border passenger transport.²

Structure

The study is structured around the main research topics. Because fatigue has previously been defined in various ways, the second chapter sets out to define fatigue more clearly, and to examine its symptoms and its effects on driving. In Chapter 3, we examine the prevalence of driver fatigue in Europe, as well as the difficulties of detecting fatigue. The link between fatigue and safety is then examined in Chapter 4, which considers crash data, crash causation studies, sleep-related accidents and the effect of driving hours and rest breaks on crashes. This chapter also examines broader effects that fatigue may have, for example, on a driver’s wellbeing and private life. A major element of the study is its examination of the causes of driver fatigue, with a focus on the relationship between fatigue and drivers’ working conditions. In Chapter 5, fatigue-causing factors are considered with the aid of a differentiation between the mental and physiological effects of underload and overload, long working hours, insufficient breaks and rest, unpredictable and irregular working schedules, and uncomfortable environmental conditions. The causes identified in Chapter 5 provide the basis for the countermeasures considered in Chapter 6: measures for drivers, employers, the EU and the Member

1 For the project website see: <https://www.etf-europe.org/activity/bus-and-coach-road/>

2 While both buses and coaches are modes of passenger transport, a coach is often seen as a special type of bus that usually carries passengers over long distances. Often coaches differ from other buses in their quality of service and comfort. However, in the context of this project, the terms “buses” and “coaches” are used interchangeably.

States to implement. The final part of the study, Chapter 7, includes the conclusion.

METHODOLOGY

Our research employed a mixed-methodological approach. This included an examination of secondary and primary data as well as information gathered through literature reviews, a survey of truck, bus and coach drivers, along with interviews, workshops and a seminar.

Literature review

Our literature review covered national and European studies on topics related to fatigue, including causes, consequences, and prevention. In addition, we included literature on non-European countries that confront a particular problem of driver fatigue owing to their large size and long transport routes (for example, Australia and USA), to gain a more comprehensive overview. Statistical data, where available, has been taken into account. It should be noted that most literature on fatigue in professional drivers refers to truck drivers. Fatigue in bus and coach drivers has previously received less than due attention.

Survey

Between May and July 2020, we conducted a survey of 2,861 bus, coach and truck drivers in Europe. The online questionnaire covered general questions (such as country of residence and trade union membership), the extent and the effects of fatigue, causes of fatigue and countermeasures against fatigue. The drivers were given the opportunity to explain their statements and to provide additional information in response to open questions. We conducted a statistical analysis as part of the data analysis; information on this can be found in Annex I.

The survey was translated into 16 languages and distributed through European trade union networks, including social media. A relatively high proportion of our driver respondents were trade union members. That is due to the fact that the survey was conducted during the period of the first lockdown, when the main channel for contacting drivers was via the ETF trade union

networks. It is worth mentioning that unionised drivers benefit more from fair employment terms and conditions. However, even within this driver sample, fatigue was identified as a major, chronic and recurrent problem.

We received 2,861 valid responses from the survey – 673 from bus and coach drivers and 2,188 from truck drivers. Although the number of responses from bus and coach drivers is lower than the number of truck drivers participating in the survey, this response rate is nevertheless remarkably good, given the strong impact of the COVID-19 pandemic on passenger road transport. For the most part the COVID crisis brought travel to a standstill. Many drivers became unemployed or went on leave.

The survey received responses from 26 EU countries, as well as from Norway and the UK. Most responses from bus and coach drivers were received from Austria, Belgium, Denmark, France, Italy, Poland, Spain, and the UK. Most responses from truck drivers were received from Belgium, Denmark, France, Germany, Italy, the Netherlands, Portugal, Romania, Spain, and the UK.

In respect of age distribution the largest group of respondents was aged between 45 and 54 (bus/coach drivers: 35%; truck drivers: 34%); followed by the age groups 55–67 (bus/coach drivers: 30%; truck drivers: 28%) and 35–44 (bus/coach drivers: 22%; truck drivers: 24%). Younger drivers (aged 21–34) participated to a lesser extent in the survey (bus/coach drivers: 13%; truck drivers: 14%). This distribution reflects the general age distribution in the road transport sector, with fewer young people choosing to become professional drivers. 86% of bus and coach drivers and 81% of truck drivers in our survey were “resident drivers” – residents of the country in which they normally start and end their activity. At the same time, only 6% of the bus and coach drivers and 11% of the truck drivers were non-resident drivers.³ Almost all respondents (96% of bus/coach drivers and 92% of truck drivers) were directly employed by their company.

Among the respondents, employment by an agency (2% bus/coach drivers and 4% of truck

³ The missing percentages in respect of these questions are accounted for by the response “I don’t know”.

drivers) and self-employment (2% of bus/coach drivers and 3% of truck drivers) were both very rare. This again may be because, as shown above, trade unions provided the main channel for engaging the drivers in our research.

Responses from the truck drivers showed that 49 % mainly worked in national road freight transport, 26% in international transport and 25% equally in both national and international transport. By contrast, almost 70% of the bus and coach driver respondents worked in national passenger transport. Only 6% worked in international passenger transport and, as with the truck drivers, 25% worked about equally in both national and international transport.

The effect of trade union membership on the results

Among the respondents, 84% of bus and coach drivers and 72% of truck drivers were members of a trade union. 77% of the companies for which the bus and coach drivers work for and 61% of the companies for which the truck drivers work for were covered by collective agreements. In companies with collective agreements, 89% of drivers were covered by them.

We must acknowledge that the high proportion of union membership and coverage by collective agreements is not typical for the transport sector. Since trade union representation and collective agreement coverage is often associated with better employment status, pay and working conditions, it may be assumed that the responding drivers are better off than non-unionised drivers, who constitute the majority in passenger and road freight transport – in other words, that the real situation in the sector is on the whole significantly worse than the survey suggests. This should be kept in mind when interpreting the results.

Interviews, workshops, seminar

Our research also included interviews (based on pre-structured questionnaires) with drivers, trade

union representatives and other experts. These enabled the researchers to gain qualitative information through more extensive exchanges on specific topics, in particular: the effects of employment and working conditions on driver fatigue, the effects of fatigue, the effectiveness of countermeasures, as well as the distribution of competences and responsibilities for the reduction of fatigue in the sector.

We interviewed 10 bus and coach drivers from 7 countries and 11 truck drivers from 10 countries. Our interviews with trade union representatives gathered valuable insights into nation-specific circumstances, frameworks, and debates on fatigue and road safety, as well as related trade union demands and practices. In total, we conducted 10 interviews with trade union representatives from 8 trade unions. Since our research on fatigue covered multiple disciplines, we also conducted five interviews with academics and a law enforcement representative working in the field of fatigue, to gather additional information understanding. The academic interview partners were based in universities or national research institutes in Belgium, Germany, Sweden, and the UK.

The project included two workshops – one on freight and one on passenger transport – to examine the specificities of the two sub-sectors in more detail – and a seminar. These were attended by drivers and trade union representatives from various European countries, researchers with relevant expertise, highway police inspectors and an occupational physician. Participants in the workshops and the seminar defined core factors contributing to driver fatigue and discussed possible countermeasures.

In November 2020, ETF published a leaflet summarising some of the main survey results on the leading causes of driver fatigue, road safety and countermeasures against fatigue (ETF 2020).

2

DEFINING FATIGUE

Various definitions of fatigue are found in the research literature we reviewed. However, there is largely a consensus that fatigue is a state caused by prolonged exertion. According to Philips (2016) – a Norwegian researcher:

Fatigue is a suboptimal psychophysiological condition caused by exertion. The degree and dimensional character of the condition depends on the form, dynamics and context of exertion.

Fatigue manifests itself physiologically, cognitively and emotionally. It leads to a decrease in mental and physical functioning and can affect work performance and health over the shorter or longer term (European Commission 2018b; Phillips 2016). While there are many different sources of fatigue, in general, it results from insufficient rest and sleep between activities. It can also result from particular aspects of work- or non-work-related life, as well as from individual traits (see chapter 5).

Fatigue and sleepiness

The concepts of fatigue and sleepiness are often used interchangeably. However, the two concepts can be distinguished. For example, the European Commission (2018b) states that:

Sleepiness can be defined as the neuro-biological need to sleep, resulting from physiological wake and sleep drives. Fatigue has been, from the beginning, associated with physical labour or, in modern terms, task performance.

Similarly, there are differences in the causes, respectively, of fatigue and sleepiness. For instance, Williamson *et al.* (2014, p. 225) state that:

The causes of sleepiness uniquely relate to sleep (i.e., amount, quality, time since awakening and time of day effects) whereas the causes of fatigue can relate to task-related factors (i.e., duration and workload) as well as sleep-related factors.

Even so, the European Commission (2018b) acknowledges, that:

Although the causes of fatigue and sleepiness may be different, their effects are very much the same, namely a decrease in mental and physical performance capacity."

Furthermore, Lupova (2018) states that sleepiness and fatigue are intertwined and it is difficult to isolate one from the other. It is also likely that sleepiness and fatigue are influenced by each other. This study largely refrains from differentiating between the two: we use the term "fatigue" broadly to include sleepiness.

Fatigue is manifested in various physiological and psychological symptoms (European Commission 2021a; Klauer *et al.* 2006; Lupova 2018; Nordbakke/Sagberg 2007). These can include a significant decrease in the heart rate, a lowered oxygen level in the blood, decreased muscle strength, changes in brain activity, lack of eye movement and a smaller degree of eye opening, as well as frequent nodding and a

decrease in neck muscle tone (Lupova 2018). The effects of these cognitive and motor impairments include a narrowing of the perceptual field, a reduction in attention levels, heightened stress and anxiety levels, reductions in reaction times, as well as drowsiness, and difficulties coordinating different parts of the body. In a person driving a vehicle, these effects can lead to:

- poor steering control, for example, drifting out of the lane
- increased reaction times, for example, delayed braking
- no memory of the last few kilometres travelled

- poor speed tracking and unconscious variations in speed
- reduced attention such as failure to check mirrors.⁴

Experiencing fatigue is not a conscious or planned decision; it is rather an autonomic mental and physical process (European Commission 2018b; Sando/Mtoi/Moses 2010). It is important to emphasise that fatigue cannot be overcome by motivation, training, or willpower (Caldwell *et al.* 2009).

⁴ See also : Beaulieu (2005); Lupova (2018); Société de l'assurance automobile du Québec (2011)



3

THE PREVALENCE OF FATIGUE

“This problem [driver fatigue] is very common, but unfortunately it is not always pointed out accordingly ... it is concealed by many drivers for fear of losing their job.”

(Austrian bus/coach driver)

“I always feel tired.”

(Polish truck driver)

The results of our analysis suggest that driver fatigue in bus, coach and truck drivers is a widespread problem in Europe. Many drivers see fatigue as a characteristic feature of the driving profession. Moreover, a common assumption in the research literature is that professional drivers are particularly affected by fatigue. However, while there are studies available on the extent of general driver fatigue in Europe, no recent study can be found that focuses on fatigue in professional drivers in Europe. A number of country-based studies provide insight into the scope of the problem, but these studies are hardly comparable with one another, as they vary in their survey methods, target groups, and research questions (see boxes 1 and 2 on pages 14 and 15). Relevant indicators of the prevalence of driver fatigue are the feeling of tiredness while driving and the incidence of actually falling asleep at the wheel (also referred to as microsleep). Researchers most commonly take self-reporting by drivers as the main evidence of driver fatigue. Technology-based studies of professional drivers (using, for example, driving simulators) are generally very rare, and

non-existent in respect of bus and coach drivers in interurban and cross-border passenger transport. The problem with data based on self-reporting is that the drivers may not recognise the symptoms of driver fatigue, or admit that they are personally affected by it, because of a biased understanding of fatigue (Williamson *et al.* 2011). The number of drivers affected by fatigue is therefore believed to be higher than is reported in most studies.

We assessed the extent of driver fatigue by means of a series of questions covering:

- experience of tiredness while driving
- the incidence of falling asleep at the wheel (microsleep)
- unplanned vehicle stops due to fatigue;
- wanting to stop the vehicle due to fatigue but not being able to.

The results are shown in the following sections.

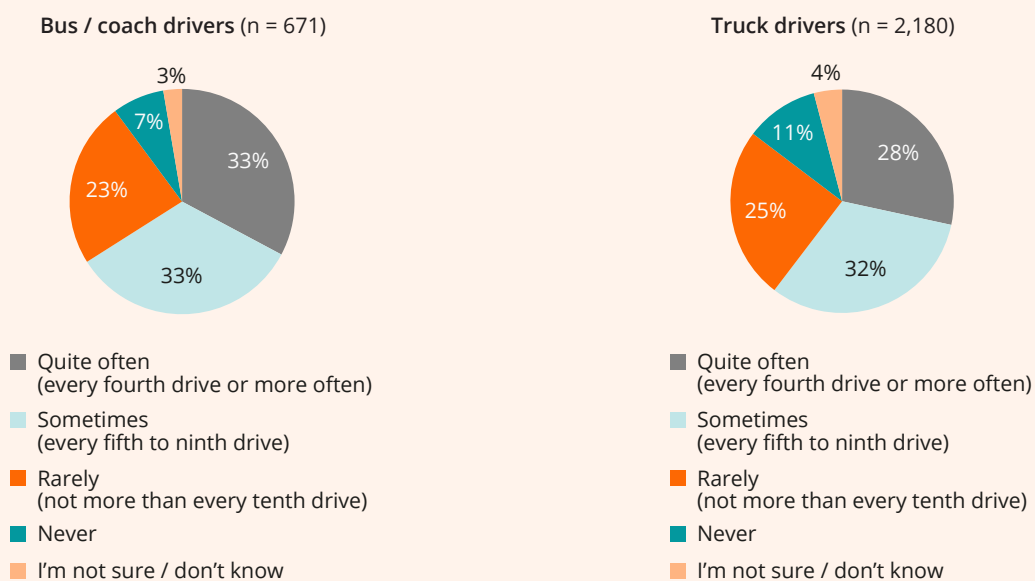
In our survey, bus, coach and truck drivers were asked how often they drove while feeling tired (see Figure 1). 33% of bus and coach drivers and 28% of truck drivers indicated that they often (every fourth drive or more often) felt tired when driving, while 33% of bus and coach drivers and 32% of truck drivers felt tired sometimes (every fifth to ninth drive) when driving. Adding these numbers, 66% of bus and coach drivers and 60% of truck drivers can be understood to have been regularly affected by fatigue. By contrast, only about a quarter of bus and coach drivers (24%) and truck drivers (25%) were rarely affected (no more frequently than every tenth time) by fatigue. Only 7% of bus and coach drivers and 11% of truck drivers had never experienced fatigue while driving.

Box 1: The extent of fatigue and sleepiness at the wheel of bus and coach drivers (literature review)

Studies of bus and coach drivers mainly working in urban public transport have revealed that nearly half of the drivers surveyed had experienced fatigue, while roughly a quarter had fallen asleep at the wheel:

- Regarding urban public transport, a survey in the city of London of 1,353 bus drivers in 2019 found that 37% of respondents had had to fight sleepiness in order to stay awake while driving the bus two or more times a month, and that 17% had fallen asleep at the wheel at least once in the previous 12 months (Filtiness *et al.* 2019).
- In a Swedish study from 2016 among city-based bus drivers (n=231) in Stockholm, 19% of respondents reported having had to struggle to stay awake while driving the bus 2-3 times each week or more, and nearly half had experienced this at least 2-4 times per month (Anund *et al.* 2016).
- A study from 2015 on fatigue in various transport sectors in Norway found that 21% of all express/airport bus drivers surveyed (n=80) and 27% of drivers of local buses (scheduled buses and school buses, n=312) reported “excessive daytime sleepiness”. 38% of the express/airport bus drivers and 49% of the drivers of local buses reported that they sometimes or often worked even though they felt too exhausted to do so. Furthermore, 25% of express/airport bus drivers and 26% of drivers of local buses stated that they had fallen asleep while driving, one or more times (Phillips/Sagberg/Bjørnskaug 2016).

Figure 1: How often do you drive while feeling tired?



Source: own survey

Box 2: The extent of fatigue and sleepiness at the wheel of truck drivers (literature review)

Our literature review showed that – depending on the methodology used – between 28% and 81% of truck drivers experience driver fatigue, and between 4% and 46% of have fallen asleep at the wheel:

- A recent survey on driver fatigue among truck drivers was conducted by the British trade union Unite, which interviewed 4,345 truck drivers in the UK in the summer of 2019. The study found that 81% of respondents regularly felt fatigued at work. In the last 12 months 57% had had to stop work because of excessive tiredness, while 31% admitted they had made errors while driving owing to tiredness. 4% had fallen asleep while driving in the previous 12 months.⁵
- Similarly – but less representatively, owing to the very limited number of truck drivers participating (n=52) – a study on fatigue in the Netherlands in 2011 found that 80% of truck drivers had experienced driver fatigue. In this study almost a quarter (23%) had fallen asleep at the wheel in the previous year (Goldenbeld *et al.* 2011).
- The study from 2015 on fatigue in various transport sectors in Norway found that 28% of all truck drivers surveyed (n=216) reported “excessive daytime sleepiness”, which was the highest level among the sectors studied (the corresponding figures for other transport workers were: container and fish carriers 25%, airport bus drivers 21%, passenger train drivers 18, and taxi drivers 16%). In this study 36% of truck drivers stated that they had fallen asleep while driving, once or more (Phillips/Sagberg/Bjørnskau 2016).
- A German study surveyed 353 truck drivers in July 2017 and found that 46% of respondents had (at some time) fallen asleep at the wheel at least once and 22% had fallen asleep more than once (DVR 2018)

Not surprisingly, the results of our data analysis indicate that a feeling of tiredness is also a significant predictor of falling asleep while driving the vehicle.

As far as “microsleep” is concerned, 24% of bus and coach drivers and 30% of truck drivers in our survey indicated that they had fallen asleep while driving at least once in the previous 12 months (see Figure 2). 8% of bus and coach drivers and 11% of truck drivers had fallen asleep more than three times within the previous 12-month period.

These results need to be considered in the context where, as pointed out in the context of the interviews, drivers tend to be very cautious

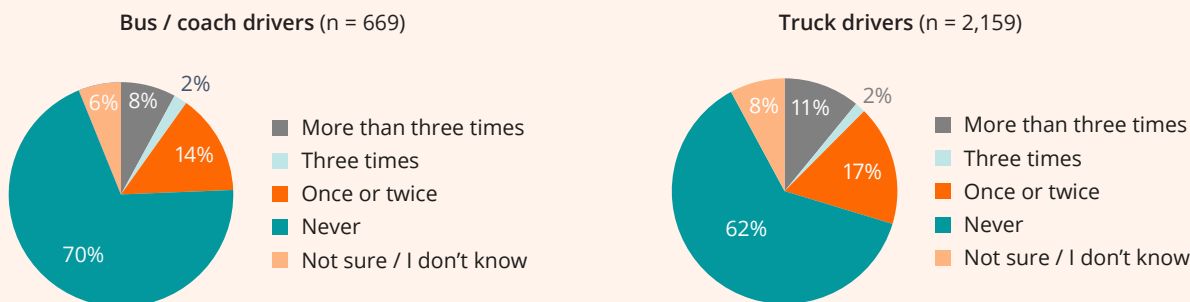
when talking about falling asleep at the wheel, as they feel this could have immediate repercussions on their employment. For this reason, the actual percentage of drivers falling asleep at the wheel is likely to be much higher than our survey results show.

On the topic of unplanned vehicle stops, we asked the drivers whether, owing to fatigue, they had had to make unplanned stops during the previous 12 months. The results show that only 36% of bus and coach drivers, but 66% of truck drivers, had had to stop at least once. 26% of truck drivers had had to stop even more than three times (see Figure 3).

By comparison with truck drivers, few bus and coach drivers reported having to make

⁵ Internal paper, for a summary see: Unite (2019)

Figure 2: In the past 12 months, how often have you fallen asleep while driving?



Source: own survey

unplanned stops owing to fatigue. This can be explained by the fact that bus and coach drivers, with passengers on board and strict schedules to uphold, are very rarely able to make stops at their own discretion without putting their employment at risk.

A follow-up question in the survey looked further into this issue. The drivers were asked how often they wanted to stop because of fatigue but were unable to do so (figure 4). Here the results between the groups of drivers were quite similar: 57% of bus and coach drivers and 51% of truck drivers in our survey had been in that situation at least once in the previous year. 25% of bus and coach drivers and 27% of truck drivers had even experienced it more than three times. These responses indicate that drivers had had to keep on driving even though they did not feel fit to do so, and would rather have pulled over to take a break. Besides the fact that bus and coach drivers may have passengers on board and a timetable to follow, the reasons why drivers are often

not able to stop the vehicle when feeling fatigued is explored in more detail in chapter 5.

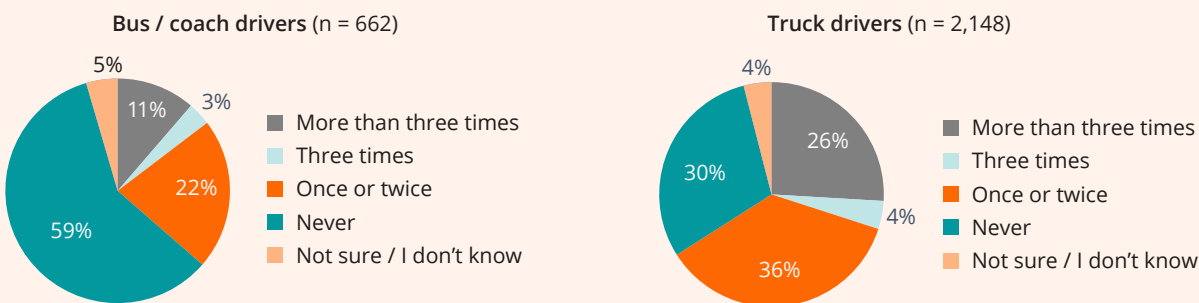
In addition, we conducted statistical analysis to investigate any associations between driver fatigue and various factors. This analysis was based on the question “How often do you drive while feeling fatigued?”⁶ Respondents were divided into one group “quite often” or “sometimes” driving while feeling fatigued, and another group “rarely” or “never” driving while fatigued.

European regions

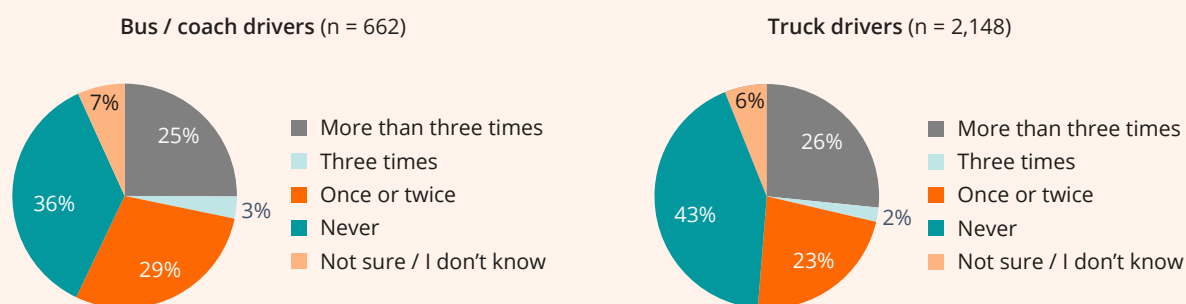
The analysis of the results by European regions show that driver fatigue is a common problem in Europe (see also annex I). The results show slight differences between country clusters. Among truck driver respondents from northern Europe (Denmark, Norway, Sweden Finland) only 34% reported being affected by fatigue, whereas the corresponding figure for those from most other

⁶ See Annex I for the methodological explanation and Chapter 5 for further discussion

Figure 3: In the past 12 months, how often did you have to stop the vehicle (unplanned) due to fatigue?



Source: own survey

Figure 4: In the past 12 months, how often did you want to stop owing to fatigue but were unable to?

Source: own survey

parts of Europe was between 61% and 73%. Note, however, that the number of responses from Nordic countries is limited (total: 137). With bus and coach drivers, the numbers are more divergent. While those in northern Europe (59%) experienced fatigue almost as often as drivers in other regions (for example western central Europe: 63%), the rate of drivers feeling fatigued while driving was especially high in the west of Europe, (89%) and in eastern central Europe (75%).⁷

Factors that strongly correlate with driver fatigue are the length of working hours and the way that working hours are documented. This finding points to the high importance of drivers' working conditions, which will be taken up in Chapter 5.

Working hours

Working hours for bus, coach and truck drivers are frequently very long. Despite the fact that the participants in our survey were mostly organised in trade unions and covered by collective bargaining agreements, many of them worked excessively long hours. Almost 20% of the bus and coach drivers responding worked more than 50 hours a week and around 40% worked 41–50 hours – even though many of them were on short time working, or were out of work altogether, owing to the COVID-19 pandemic at the time of the survey. 53% of truck drivers in our survey worked more than 50 hours a week and an additional 35% worked 41–50 hours. The 40-hour week, is virtually non-existent in road freight

transport. In addition, respondents explained that time spent on work-related tasks is not acknowledged as working-time by the employers (a definition of activities counting as working time in road transport is provided in Directive 2002/15/EC and includes driving, assistance in loading and unloading, assisting passengers boarding and disembarking from the vehicle, cleaning and technical maintenance, all other work intended to ensure the safety of the vehicle, its cargo and passengers). As Figure 5 shows, the longer the working hours, the more often drivers are affected by fatigue.

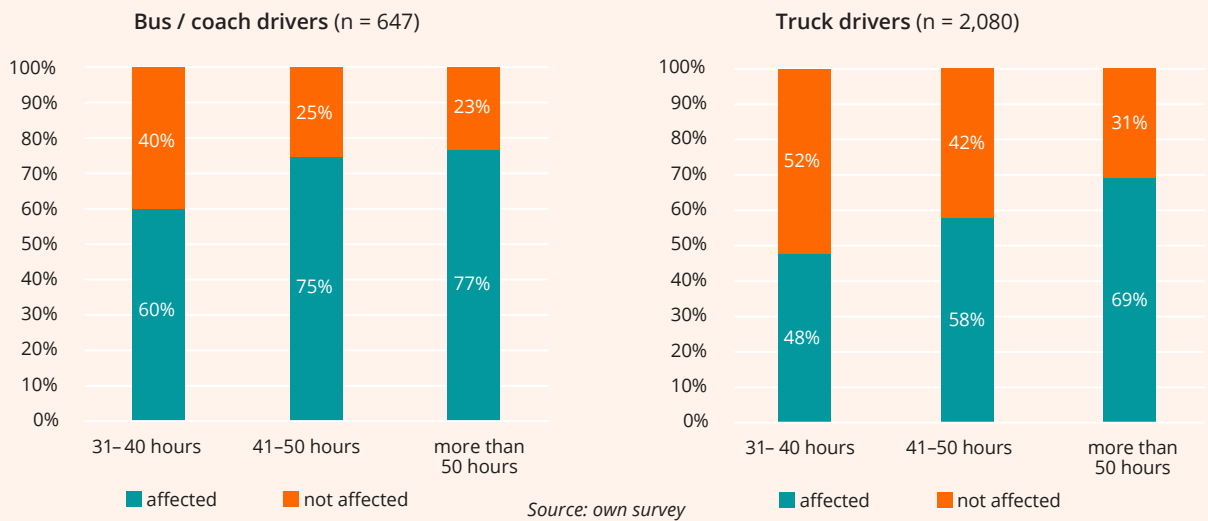
With bus and coach drivers, 77% of those working more than 50 hours a week experienced fatigue, while the percentage was somewhat smaller among those working 41–50 hours (75%) and those working 31–40 hours a week (60%). As for truck drivers, 48% of those working 31–40 hours were affected by fatigue, but 58% of those working 41–50 hours and 69% of those working more than 50 hours were similarly affected.

Documentation of working time

The way working time is documented also shows a correlation with driver fatigue. Working time is not always strictly documented: only 61% of bus and coach drivers and 52% of truck drivers in our survey reported that their working time was rigorously documented by their company. 12% of both bus and coach drivers and truck drivers indicated that working time was documented sporadically, and 9% of the bus and coach drivers and 16% of the truck drivers reported that their company did not document working hours at all.

⁷ For a definition of these regional divisions ("country clusters"), see Table 7 in the Annex to this report

Figure 5: Working hours and driver fatigue



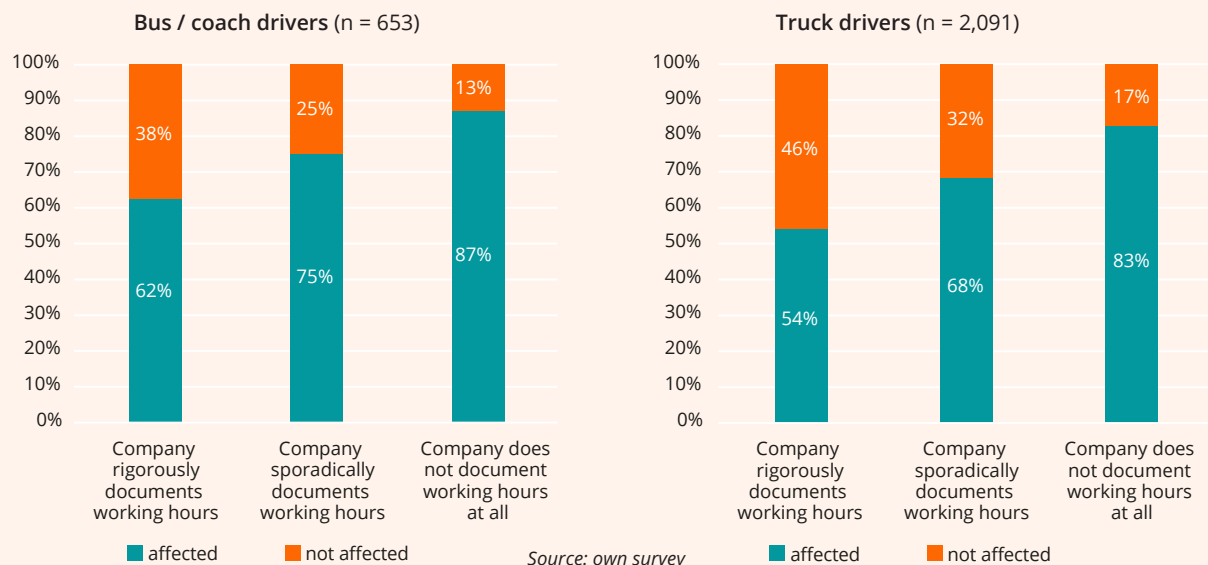
The share of driver respondents reporting proper documentation of their working time is reckoned to be relatively high by comparison with the actual situation in the transport sector. In the interviews we conducted, trade union representatives and drivers clearly state that proper documentation of working time was less widespread than is indicated by the survey results. The high proportion is due to the fact that most of the participants in the survey were trade union members, and thus covered by collective bargaining agreements. It also remains unclear whether the documentation of working time includes all work-related tasks or just a selection of (paid)

tasks. Interestingly, while 89% of the truck drivers reported using tachographs, only 61% of bus and coach drivers used them.⁸ The tachograph mainly documents driving time and only indirectly the working time.

In companies where working hours are rigorously documented, drivers are less affected by fatigue than in companies that only sporadically document working hours or do not document working time at all (figure 6). Regarding bus and coach drivers in our survey, 62% of drivers in

⁸ According to EU rules, the use of tachographs is mandatory for trucks weighing more than 3.5 tonnes and commercial passenger vehicles with a capacity of over 9 people, including the driver.

Figure 6: Documentation of working hours and driver fatigue



companies that rigorously document working hours were affected by driver fatigue, while 75% were affected in companies where working hours are documented sporadically, and 87% were affected in companies that do not document working time at all. Similarly, 54% truck drivers in companies that rigorously document working time reported being affected by fatigue, compared to 68% of drivers in companies that sporadically report working hours, and 83% in companies that do not document working time at all. These results provide important indicators of the causes of fatigue, and of possible countermeasures.

Does age affect driver fatigue?

The results regarding the significance of the age of the driver as a causal factor in driver fatigue are various. Some available studies conclude that age is related to driver fatigue, while other studies do not find such a relationship. To understand the divergent results, we need to remember that driver fatigue is often the result of a mix of factors. The study of driver fatigue by the European Commission (2021a) lists young people as a special risk group. Other studies, too, come to the conclusion that drowsy driving decreases with age (Filtner, *et al.* 2019; Higgins *et al.* 2017). However, there are also studies that find that older drivers tire more quickly than younger drivers.

The reasons given include older drivers' being more sensitive than younger drivers to irregular working hours and night shifts, and more likely to suffer from sleep disorders (Goldenbeld *et al.* 2011). Health-related issues causing sleeping difficulties also increase with age (Phillips/Nævestad/Bjørnskau 2015). Lastly, results can be found to show that the risk of drowsy driving plotted against age delineates a U-shaped curve, with both younger and older drivers being disproportionately affected (Mahajan *et al.* 2019). In a similar way, the research on the effects of driving experience on driver fatigue also comes to divergent results, and it remains unclear whether inexperienced drivers are more likely to get fatigued than experienced drivers (Braeckman *et al.* 2011;

Phillips/Nævestad/Bjørnskau 2015). All in all, it is therefore not possible to determine on the basis of existing studies that a driver's age is a decisive factor contributing to driver fatigue.

Our own research also comes to no clear conclusion on the significance of age as a factor in this respect. Our data analysis of the results of the survey concerning factors associated with driver fatigue (see Annex I), indicates, with regard to truck drivers, that the youngest group of drivers is most affected by fatigue (aged 21–34: 70%), and that fatigue decreases continuously with increasing age (for example, aged 55–67: 58%). While 37% of the respondents from the youngest age group reported falling asleep at the wheel in the last twelve months, the percentage reporting a similar event also decreased continuously with increasing age, and was 28% for the oldest age group (aged 55–67). With regard to bus and coach drivers, the results of the data analysis are less clear: the differences between the age groups are not as marked. Even so, the youngest age group of drivers was more affected by fatigue (aged 21–34: 72%) than the oldest age group (aged 55–67: 62%). In addition, younger drivers (30%) experienced microsleep more often than older drivers (aged 55–67: 22%).

The results from our interviews, workshops and seminar pointed the other way. It was a matter of consensus among participants that driver fatigue is much more pronounced among older drivers. It was also pointed out that the average age of drivers is increasing, and thus the problem of driver fatigue is potentially getting worse. Nevertheless, younger drivers seem to be more often involved in fatigue-related accidents. However, it was also remarked that younger drivers typically get the more difficult shifts (such as night shifts), while older and more experienced drivers are less willing to go along with extreme requests by the employer, as they feel more established. It was also noted during the workshops that drivers who are permanently affected by fatigue would change their profession sooner or later, so would not work as drivers until retirement.



4

FATIGUE AND ROAD SAFETY

“It’s not a bale of hay you are transporting, it’s people. One or two accidents more due to fatigue are one or two too many.”

(Belgian bus/coach driver)

“I am sitting in a weapon: 40 tonnes at 80 kph.”

(German truck driver)

“There are high numbers of accidents due to driver fatigue, but this is difficult to prove.”

(Law enforcement representative)

Numerous initiatives are being taken at European and national levels to increase road safety. In fact, the number of fatalities in accidents has been decreasing for years (European Road Safety Observatory 2019). This is particularly remarkable given that the number of vehicles travelling on European roads has substantially increased over the years. Despite this progress, the target set by the European Commission of reducing road deaths by half over the period 2010–2020 has not been reached (Adminaité-Fodor/Graziella/Jost 2019). In 2018, the European Commission adopted a new Strategic Action Plan for Road Safety, which includes the target of halving the number of serious injuries by 2030 (relative to 2020 levels).

The European Commission, however, sets no goals with regard to commercial road transport, and gives no specific attention to fatigue in professional drivers. This is particularly surprising in

a context where it is acknowledged that central objectives of a successful road safety strategy are to avoid collisions of any vehicles, especially those with large differences in mass, and to reduce the main risk factors for crashes, including fatigue (ETSC 2011). Indeed, road accidents involving heavy vehicles tend to be more serious than other collisions because the vehicles’ size and mass lead to grave consequences for all road users involved in the accident (U.S. Department of Transportation, USDOT 2019). Data from the European Transport Safety Council’s (ETSC) Road Safety Performance Index Project shows that fatal road collisions involving trucks – referred to as Heavy Goods Vehicles (hereafter HGVs) – are much more frequent than those involving other vehicles. On a per-km basis, up to three times as many people die in collisions involving HGVs as die in collisions involving only non-goods vehicles (Adminaité-Fodor/Jost 2020). Although deaths in bus and coach collisions make up only a small percentage of the total number of road deaths, a single collision can cause a relatively large number of deaths, because of the number of passengers on board. Comparative statistical evidence on the involvement of buses, coaches and trucks in crashes in Europe has been made available through the CARE database, which was set up as part of the Satefty.Net project (2004–2008), funded by the European Commission. CARE is a Community database on road accidents that have resulted in death or injury, comprising detailed data on individual accidents, as collected by the Member States. The database shows that in Europe in 2016 (the latest available data) 4,002

Table 1: Percentage of all road fatalities occurring in accidents involving heavy goods vehicles, and buses and coaches, EU, 2007–2016

	2007	2010	2013	2016
Heavy goods vehicles	16%	15%	15%	16%
Buses and coaches	3%	3%	3%	2%

Source: CARE database, May 2018 (European Road Safety Observatory, 2019).

people were killed in road accidents involving HGVs, and 594 people in accidents involving buses or coaches. HGVs caused 16%, and buses and coaches 2%, of all road fatalities in 2016 (European Road Safety Observatory 2019).

Accident risk rates

The risk of fatalities in accidents involving HGVs, coaches and buses varies between the EU Member States. The EU-average fatality rate in accidents involving HGVs is 8.1 per million population, and ranges from around 1.5 in Estonia to 20.6 in Poland. For accidents involving buses or coaches, the EU-average fatality rate lies at 1.2 per million population and is lowest in Luxembourg and Slovenia (0) and the highest in Estonia (11.4). Even though the total number of road fatalities involving HGVs, buses and coaches fell by about 40% between 2007 and 2016, the overall percentage share of fatalities in accidents involving HGVs, coaches and buses has hardly changed over the past ten years (see table 1). The overall number of deaths in accidents in Europe has been declining in this period as well. The total number of deaths involving HGVs, buses and coaches over this period was reduced at the same pace as the overall number of road deaths.

The CARE data also shows that 19% of collisions involving HGVs occurred on motorways, 56% on rural roads and 24% on urban roads. Accidents involving HGVs and buses or coaches often kill or injure, not only the drivers and passengers in these vehicles, but also other road users. Almost 50% of those who died in 2016 in road accidents that involved HGVs were travelling by car, 16% were pedestrians and 14% were occupants of HGVs. 34% of those killed in bus and coach accidents were car occupants, 31% were

pedestrians and 17% were occupants of buses or coaches.

Driver fatigue is seen as one of the biggest safety issues facing road transport. It leads to an increased tendency to withdraw mentally from driving tasks, with a deterioration of driving performance that manifests itself in slower reactions, impaired hazard perception and diminished steering performance, along with other consequences (see Chapter 2). The implications for professional drivers and other road users are serious. Fatigue-related crashes often have particularly grave consequences owing to the drivers' significant loss of control, which often leads to an unintended vehicle trajectory, with no braking response (Eskandarian/Mortazavi/Sayed 2010). Fatigued drivers are more likely to be involved in crashes resulting in the fatal injury to themselves, their vehicle's occupants or other road users (European Commission 2018b).

Fatigue indicators in accidents

Unfortunately, it is not yet possible to determine precisely how many fatigue-related crashes occur. Studies that analyse fatigue as a cause rely on self-reporting, data from police reports and detailed accident investigations. Crash investigators can look for clues that fatigue may have contributed to an accident, but such clues are not always evident (National Highway traffic safety administration, NHTSA n.y.). Fatigue is difficult to discern externally – no blood, breath, or other test is currently available to quantify levels of sleepiness in a driver at the site of an accident (European Commission 2018b).

Summarising results of different studies, the following indicators (among others) have been used to identify fatigue-related crashes:

- The crash is serious
- The vehicle has run off the road
- There are no skid marks, nor any other evidence of braking
- Witnesses report lane drifting before the crash
- The driver has not attempted to avoid a crash;
- The problem occurs late at night, early in the morning or in mid-afternoon

- Other causes have been eliminated – for example, mechanical defects, speeding, excess alcohol, or bad weather.⁹

This approach is heavily based on considering the effects of fatigue when it is too late, rather than on preventing fatigue from occurring in the first place, by recognising its causes, and the magnitude of the problem. Our research results indicate that some drivers do not know the symptoms of fatigue and may not have been aware that they were fatigued before an accident. Out of fear of negative consequences, drivers may also not admit to driving while fatigued. There is general agreement that any percentages given in crash data underestimate the true magnitude of the problem, since the evidence for fatigue-related crashes is often questionable (ETSC 2001; Williamson *et al.* 2011). The actual number of crashes caused by fatigue can therefore be assumed to be much higher than the statistical evidence relating to driver fatigue shows.

Very few of the available studies on fatigue and road safety quantify, as a percentage share, the role of fatigue in accident causation data; and most of these studies date back several years – in some cases over 15 years. What is noticeable is that the percentage of fatigue-related accidents varies according to the type of study, the region, and the method. A starting point for an insight that covers both bus and coach drivers and truck drivers is the accident causation database (SafetyNet Accident Causation System – SNACS) that was maintained during the SafetyNet Project. It should be noted, however, that the project dates back more than ten years. While this database did not include the variable, “fatigue”, the European Road Safety Observatory (2019) points out that:

The critical event of late action could be linked to the cause observation missed, which is a consequence of fatigue, itself a consequence of an extensive driving spell.

“Late action” was seen by the Observatory to have caused 16% of all accidents involving buses, coaches and HGVs. Other studies report lower percentages. A British study from 2010 of drivers employed at bus depots within 30 miles of Edinburgh (n=677) found that 7% of the drivers reported having had an accident and 18% a near-miss due to sleepiness while working (Vennelle/Engleman/Douglas 2010). In the 2019 survey of 1,353 bus drivers working in urban public transport in London, 6% of respondents reported having a crash while driving a bus because they were sleepy, and 37% had had a close call (Filtress *et al.* 2019). The Swedish study, from 2016, of city-based bus drivers (n=231) in Stockholm reported that 19% of the drivers had experienced at least one fatigue-related incident during the previous 10 years (Anund *et al.* 2016).

In our research, we attempted to assess the impact of fatigue on road safety by asking our survey respondents whether they had experienced an accident owing to driver fatigue in the previous 12 months. 5% of bus and coach drivers and 3% of truck drivers reported being involved in a crash at least once in that period owing to fatigue.

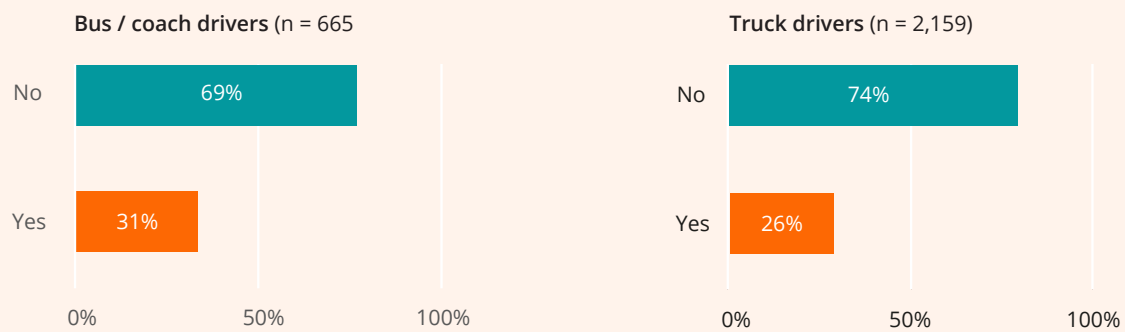
If we extrapolate the numbers of our survey sample to all drivers in the sector in the pre-Brexit EU28, we can get a rough estimate of the extent of fatigue-related accidents in Europe. According to this estimate, about 113,000 bus and coach drivers and 100,000 truck drivers could have experienced a road crash due to driver fatigue in the previous 12 months. This estimate is based on employment data from 2017 (2.3 million bus and coach drivers and 3.3 million truck drivers).¹⁰

Near-misses

Another important indicator of the threat fatigue poses to road safety is the occurrence of near-misses. The terms “near-miss”, or “close call” describe a narrow escape from what could otherwise have been an accident. Near misses add to the total of actual accidents and potential accidents with a high probability of occurring. As in aviation, it must be understood that that

⁹ See: European Commission (2018b); National Highway traffic safety administration (NHTSA) (n.y.)

¹⁰ For employment data see: European Commission (2020)

Figure 7: Have you almost had an accident due to fatigue in the last 12 months?

Source: own survey

near misses on the roads represent potential catastrophes. They need to be taken seriously, so that action can be taken to reduce the likelihood of recurrences. In truly safe transport, neither accidents nor near misses would occur. In our survey we asked the participating drivers if they had experienced any close calls due to fatigue in the previous 12 months. The results are shown in Figure 7.

As Figure 7 shows, 31% of bus and coach drivers and 26% of the truck drivers reported having had at least one close call in the previous year. The somewhat higher frequency of both actual and potential accidents experienced by bus and coach drivers, by comparison with truck drivers, is explained by the fact that bus and coach drivers are more often on the road in dense and busy urban traffic. The risk of an accident occurring increases when traffic is denser.

Factors affecting accident rates

While good quality data on fatigue-related accidents is lacking, several studies have researched the relation between fatigue-causing factors (see Chapter 5) and safety. These studies show that accident rates vary according to the **time of day** (Adminaité-Fodor/Jost 2020; Akerstedt/Philip 2018; Amundsen/Sagberg 2003; ETSC 2011; Knippling 2015; Parkes/Gillan/Cynk 2009; Williamson *et al.* 2011). The maximum accident risk occurs between 2.00 a.m. and 5.00 a.m., with a secondary but lower peak level around 3.00 p.m. to 4.00 p.m. The peak level of crash risk, at night, can be ten times higher than daytime levels. Research evidence supports the conclusion

that this is related to the endogenous body clock in humans (the circadian rhythm), which manifests a near 24-hour cycle driven by an internal clock, with peaks and troughs occurring throughout the cycle. The lowest points of the circadian rhythm produce the strongest drive to sleep, with alertness beginning to decrease in the late evening, and reaching its lowest point between 2:00 a.m. and 4:00 a.m. Another, but smaller dip in alertness is experienced in the early afternoon between 1:00 p.m. and 3:00 p.m. (Filtner *et al.* 2019).

Sleep loss – cumulative sleep deprivation, as well as hours of continuous wakefulness – have also been associated with increased risks of road accidents (Knippling 2015; Valent *et al.* 2010). Any reduction in the quantity or quality of sleep, or extension of the time awake, produces a sleep debt and a drive to sleep (Williamson *et al.* 2011). Estimates range between a three- to eight-fold increase in crash risk due to insufficient sleep the night before a trip. The risk of an accident is also higher for people with untreated sleep disorders (Anund *et al.* 2015). Studies of driving tasks show that the length of **time spent driving** affects the quality of driving performance (Akerstedt/Philip 2018; Beaulieu 2005; Williamson *et al.* 2011). Both working long hours, and long periods of uninterrupted driving, have been associated with higher rates of accidents (Amundsen/Sagberg 2003; Dunn/Williamson 2012; European Commission 2018b; Thiffault 2011). An ETSC (2011) report points to a study showing that after eleven hours of work, the risk of being involved in a collision doubles.

FURTHER EFFECTS OF FATIGUE

“You are simply not present when you are fatigued.”

(Danish truck driver on the impact of fatigue on family life)

As the previous section strongly indicates, accident data on its own is an inadequate basis for accurately assessing the full effects of driver fatigue. Many truck, bus and coach drivers suffer from the effects of fatigue but do not become involved in accidents, nor in close calls. The effects of fatigue on the individual are manifold. For example, a study in the mining sector shows that fatigue increases the risk of occupational accidents and long-term health problems (NSW Mine Safety Advisory Council/NSW Government 2009). The study cites such long-term health issues associated with fatigue as:

- digestive problems
- heart disease
- stress

- harmful drug and alcohol use
- mental illness.

Our own findings, too, indicate that fatigue has a strong negative effect on a driver’s wellbeing and private life. Drivers explained that fatigue left them feeling too tired to participate in activities with others, and also caused them concentration problems. The Norwegian study on fatigue in various transport sectors from 2015 found that bus drivers, in particular, lacked energy after work (Phillips/Sagberg/Bjørn-skau 2016). In addition, fatigue leads to psychosocial effects and emotional exhaustion, which manifest themselves in anxiety, low mood and depression, or aggression.¹¹ Furthermore, some drivers to compensate for ongoing fatigue, by taking medication and stimulants, or – worse – by resorting to alcohol and other drug abuse.

¹¹ See also Phillips (2014); Varela-Mato *et al.* (2019).



5

CAUSES OF FATIGUE, AND ITS RELATION TO WORKING CONDITIONS

Fatigue is a state caused by prolonged exertion leading to the gradual decline of physical and mental alertness. Since various factors can demand exertion, the resultant causes of fatigue are similarly various. Factors typically listed in the literature as risk factors for fatigue include: lack of sleep or poor quality of sleep (including sleep disorders), circadian rhythm (time-of-day effect), long working hours (time-on-task), and lack of stimulation (type-of-task, monotonous environment).¹² However, there are also many other relevant factors. The number and diversity of these factors makes it difficult to identify them fully. To help simplify the analysis, the existing literature on the causes of driver fatigue divides the factors into different categories. The classification is not always consistent, but the categories can be summarised roughly as follows:

- Individual factors (such as driver's sleep and health)
- Driving- and task-related factors (such as monotony of the road, availability of rest areas, heat, noise and vibrations)
- Factors related to employment- and working-conditions (such as the length of working hours, the insufficiency rest and breaks, or excessive task demands).

Interestingly, most literature on driver fatigue focuses first on sleep-related factors, such as the quantity and quality of sleep, followed by research into driving- and task-related factors

such as monotonous conditions and time-on-task demands. Causes relating to employment conditions have, by contrast, received little attention. This is particularly noteworthy, since our research shows that many factors listed as sleep-, health- or task-related in the literature are actually effects of poor working conditions. The interplay between the different types of factors is outlined below.

Generally, we can say that a variety of situations and risk factors play a role, and it is unlikely that any single set of processes lead to fatigue (Smith/Allen/Wadsworth 2007). Rather, fatigue can be considered to be the result of a complex interplay between factors. The results of our survey also point to the complexity of the causes of driver fatigue.

Our survey covers fatigue-related causes based on an initial set of 26 risks. Table 2 on page 26 provides an overview of the factors contributing to driver fatigue that were identified by the survey participants as the most significant of these 26 risks. Percentages given in the table reflect the share of respondents who rated the particular factor as "very important" or "important" in contributing to driver fatigue.

Each of these individual factors was validated by an overwhelming majority of our survey respondents. All factors got a validation rate of 60% or more, which indicates a high degree of common experience among drivers.

As we have seen, the effects of working conditions on fatigue have not been given due attention in previous studies. Even though it is well known that the fatigue-inducing effects of

¹² See for example: European Commission (2021b); NSW Mine Safety Advisory Council/NSW Government (2009); Sando/Mtoi/Moses (2010).

prolonged driving can be reduced by taking frequent breaks, hardly any study poses the question of why professional drivers keep on driving when feeling fatigued. By contrast, the results of our analysis show that working conditions play a major role not only in generating fatigue, but also in determining drivers' responses to that fatigue.

Employment and working conditions

The employment and working conditions for professional drivers are often harsh. Further-

Table 2: Factors rated very important or important in contributing to fatigue according to drivers' own experience (survey results)

Factors	Bus/coach drivers	Truck drivers
Sleep and health-related factors		
Overall health / medical fitness	83%	80%
General exhaustion	84%	80%
Not enough time to sleep	84%	79%
Poor quality of sleep	82%	82%
Interrupted sleep	77%	79%
Sleep disorders	73%	69%
Task- and work-related factors		
Extreme temperatures, heat	78%	73%
Lack of rest areas	63%	83%
Monotonous driving conditions	72%	65%
Driving at night	70%	71%
Long drives	70%	59%
Employment and working-conditions related factors		
Series of long working days without days off	85%	78%
Not enough time to rest	82%	74%
Tight schedule / scheduling demands	81%	75%
Work pressure	78%	78%
Amount of working time	75%	73%
Too few rests	72%	67%
Unfavourable sleeping conditions	67%	65%

Source: own survey

more, studies show that both working and social conditions for bus, coach and truck drivers have deteriorated sharply in recent years (Broughton *et al.* 2015; Gibson *et al.* 2017; Pastori/Brambilla 2017; Pylkkönen *et al.* 2013; Turnbull 2018; Voss/Vitols 2019). The few available studies that focus on employment and working conditions as fatigue-causing factors list long working days, unreasonable scheduling demands, financial incentives pushing drivers to drive too many hours, and penalties for late deliveries as relevant factors in the generation of driver fatigue (Amundsen/Sagberg 2003; Crum *et al.* 2001; Mahajan *et al.* 2019). A study of truck drivers at Israeli ports shows that fatigue, falling asleep at the wheel and involvement in crashes all result from difficulty finding rest stops, employer pressures, and long working hours – almost 40% of the drivers worked more than the legal limit (Sabbagh-Ehrlich/Friedman/Richter 2005). The main reason for the poor working conditions of professional drivers in Europe is seen in the liberalisation of the road freight and passenger market, which has led to a downward spiral in working conditions owing to increasing competition (Phillips/Nævestad/Bjørnskaug 2015; Voss/Vitols 2019).

A strong trend in the transport business is to sub-contract work to companies (often subsidiaries) in “low-cost countries”. Some long-distance bus operators act merely as intermediary platforms working with subcontractors who employ drivers in another country. Where business strategies are based mainly on price and cost competition, it becomes increasingly challenging for companies to operate in the transport market. Many resort to engaging drivers at low wage rates, and to circumventing laws and regulations governing working time, remuneration and social protection. Overall, increasing competition leads to the deterioration of working conditions, increasing work load and infringement of driving and rest time regulations.

ACTIVE AND PASSIVE FATIGUE

Driver fatigue can be differentiated into active and passive fatigue (Dorn 2017). Active fatigue arises from a mental or physiological overload

and can be the result of highly demanding driving conditions. Passive fatigue usually occurs when the driving task is predictable, and drivers rely on existing mental schemas, which results in mental underload and a reduction in effort spent on the task.

Passive fatigue: Mental underload

Previous studies have put special emphasis on passive fatigue from monotonous driving conditions as a risk factor (Thiffault/Bergeron 2013). The monotony may consist either in the driver's tasks or the driving environment. Originally, this issue of monotonous driving conditions was seen as the product of an uneventful, predictable, and repetitive driving environment. Long-distance drives on monotonous roads, such as in rural areas without topographical variation and little traffic, are recognised as a problem (known as "highway hypnosis"), especially in large countries such as the USA and Australia. In Europe, such monotony is less common.

A task becomes monotonous when stimulation is absent, changes are predictable or there is a high level of repetition. In general, driving, is mostly a repetitious and monotonous task, which therefore increases the risk of fatigue by producing mental or physical tiredness, or both. In particular, night driving tends to generate passive fatigue, as it is often set in very monotonous and undemanding surroundings (Thiffault 2011).

Our results also indicate that monotonous driving conditions are becoming more of an issue as increasing digitalisation takes over driving tasks. Assistance systems and, in particular, automated driving lead to an alternation between periods that require full driver attention and periods of task-related underload which generates monotony, boredom, and a lack of stimulation, where fatigue may take over. In our survey, 72% of bus and coach drivers and 65% of truck drivers identified monotonous driving conditions as an important or very important factor causing fatigue.

Active fatigue: mental and physiological overload

"Cargo doesn't talk back, but passengers do."

(Dutch trade union representative)

"[When driving a bus] you are never free – not even to take a break."

(Swedish trade union representative)

Our project work has also led us to the conclusion that active fatigue from mental overload is a major element of driver fatigue. Mental overload may result, for example, from assistance systems that, through light signals or noises, lead to overstimulation, which impairs the driver's driving ability. More common causes of active fatigue, however, are excessive work demands, such as heavy time pressure from the need to meet tight schedules, and having to drive in high-density traffic.

In the course of our research concerning mental overload, our workshop and seminar participants put a lot of emphasis on a particular cause of occupational stress experienced by bus and coach drivers: the stress of having passengers on board, which plays an important role in exacerbating fatigue. This mostly arises from the additional tasks that come from the driver's interaction with passengers – not only from communicating with and assisting them, but also from the increased noise level in the vehicle. Having passengers on board also means that drivers have little freedom to make own decisions concerning, for instance, when to take a break. From their study of bus drivers in the UK, Taylor and Dorn (2006) identify occupational demands and occupational stress, with little control by drivers over their capacity to make decisions to help cope with the demands of the job, as factors aggravating fatigue. Various studies also show that occupational stress is especially widespread among bus and coach drivers. With some tour coach operators, it is common for drivers to be required to act also as tourist guides. This means that, besides transporting the passengers, the drivers – often during breaks or at rest times – have to plan the tours, give presentations

and lead excursions. In our survey, 84% of bus and coach drivers and 80% of truck drivers identified general exhaustion as a very important or important risk factor for fatigue.

Physiological factors

Physiological overload from handling heavy cargo was also acknowledged to be a cause of fatigue. Bus and coach drivers pointed to the physically demanding work of loading and unloading suitcases. For their part, truck drivers indicated that they are increasingly kept busy with the loading and unloading of heavy goods. Such tasks are even more demanding with deliveries in the early morning or at night, when warehouse staff are not yet available at the customer's premises. Drivers also raised the issue of the sedentary, static posture that driving entails. Constant sitting in the driving position can cause tension in different parts of the body that leads to physiological overload. The lack of physical activity and the high levels of sedentary behaviour (sitting) when driving are tantamount to poor physical conditions (Varela-Mato et al. 2015). In our survey, 83% of bus and coach drivers and 80% of truck drivers identified their overall health and medical fitness as a relevant factor contributing to fatigue.

LONG WORKING HOURS

Prolonged activity leads to physical and mental fatigue (European Commission 2021a); Dunn/Williamson 2012). Frequently, fatigue can be directly associated with the time spent on a certain task (time-on-task). Chapter 4, in examining road safety and fatigue, showed that the crash rate increases with driving time. Special emphasis needs to be put on long drives. In our survey, 70% of bus and coach drivers and 59% of truck drivers reported long drives as a very important or an important factor causing fatigue.

Non-driving tasks

Driving is not the driver's only task. Non-driving work activities include, for example, loading and unloading, cleaning and technical maintenance, all other work intended to ensure the safety of the vehicle. Bus and coach drivers

are bound to look after passengers, as well as to check tickets, collect fares, load and reload luggage, and also clean and maintain their vehicles on a daily basis. Truck drivers have to attend to such non-driving working duties as loading and unloading vehicles, securing goods and cargo, and completing formalities for cross-border transport (customs regulations, accompanying documents).

The duration of individual tasks adds to the total length of working hours. The working hours of bus, coach and truck drivers are particularly long, and the time spent working can be seen to be a key cause of driver fatigue in road transport. The total time spent working has direct effects on the time available for breaks and resting. As we have seen in in Chapter 3, our survey's analysis of data on the prevalence of fatigue showed that the length of working hours was a significant predictor of whether or not drivers felt tired or fatigued while driving. The longer the hours that drivers work, the more likely they are to report feeling fatigued. In our survey, 75% of bus and coach drivers and 73% of truck drivers reported that long working hours were a very important or important factor contributing to fatigue.

Pay-related factors

Several factors are responsible for the long working hours in the transport sector. To begin with, it is barely possible for drivers to work on reduced week schedules, or even part-time, because drivers' pay is often extremely low. They often only get a minimum wage rate, and as has been clearly indicated, they get paid for less work than they actually carry out. The long hours worked barely contribute to achieving an adequate salary. Moreover, in many lower-wage countries, a driver's pay is actually based on two components. First, there is a component that in most cases is based on the national minimum wage, which is subject to income tax and social security contributions. Second, there is the daily subsistence allowance, which is not subject to social security contributions and, in the case of international truck drivers, can make up to 75% of a driver's total monthly income. This is highly

Box 3: Regulation (EC) No 561/2006 on driving times and daily and weekly rest period

Our literature review showed that – depending on the methodology used – between 28% and 81% of truck drivers experience driver fatigue, and between 4% and 46% of have fallen asleep at the wheel:

- The daily driving period shall not exceed 9 hours, except twice a week when it can be extended to 10 hours.
- Total weekly driving time may not exceed 56 hours and the total fortnightly driving time may not exceed 90 hours.
- Daily rest periods shall be of at least 11 hours, with the exception of a reduction to 9 hours a maximum of three times a week. Daily rest can be split into a 3-hour rest followed by a 9-hour rest to make a total of 12 hours' daily rest
- Weekly rest is of 45 continuous hours, which can be reduced every second week to a minimum of 24 hours. Compensation arrangements apply for a reduced weekly rest period. Weekly rest is to be taken after six days of working, except for coach drivers engaged in a single occasional service of international passenger transport, who may postpone their weekly rest period until after 12 days, in order to facilitate coach holidays.
- A derogation was recently introduced to the above rule. In international road freight transport, the driver can now be given two consecutive reduced weekly rest periods, under the strict condition that all compensation rest must then be taken
- Breaks of at least 45 minutes (separable into 15 minutes followed by 30 minutes) should be taken after 4.5 hours at the latest.

Source: European Commission (2021b)

problematic, as sickness and holiday payments as well as other social benefits, including old age pensions, are calculated only on the basis of the component that is subject to social security contributions. This factor is magnified when payments are linked to the number of kilometres driven or to output. This type of payment is in fact prohibited, but it nonetheless does occur in the transport sector, on a large scale. Payments calculated per kilometre driven often no longer reveal their character explicitly on the pay slips, where they are translated into daily allowances, so this provision cannot be properly enforced and controlled. All in all, the low pay of drivers creates pressures and incentives to continue driving, despite the fatigue that drivers experience. Non-resident drivers from low wage countries involved in international or cabotage freight

transport are particularly compelled to drive long hours, as their payment is determined exclusively by their driving time. As far as these drivers are concerned, working time is neither paid, nor documented.

The European Union has adopted a number of regulations and directives that limit driving time and define minimum break and rest periods. Regulation (EC) No 561/2006, recently amended by Regulation (EU) 2020/1054, provides a common set of EU rules for maximum daily and fortnightly driving times, as well as minimum daily and weekly rest periods for all drivers of road haulage and passenger transport vehicles (see Box 3).

Poor enforcement

Our research shows that employers are not only making maximum use of the leeway allowed

Box 4: Just-in-time delivery

“Just-in-time delivery aims to minimise expenses for companies, but adds huge pressure and stress for drivers. [...] What matters most for companies is money and deadlines Forwarders use a short delivery time as a bargaining chip in competition with one another. And , then they dump the workload on the truck drivers.”

(Romanian truck driver)

“It’s getting worse because the industry is changing: Online sales are going up [...]. Customers are told if they make an order today it will get there tomorrow - [...] more night time work [and] pressure trying to meet the target. ...”

(British truck driver)

Just-in-time (JIT) delivery is a methodology aimed primarily at reducing times and storage requirements within the production system as well as response times from suppliers and to customers. Just-in-time delivery has gained particular momentum with the rise of e-commerce and the frequent promise to the customer to deliver goods the very next day. With a just-in-time delivery strategy, the supply-chain management aims to synchronise orders with production or delivery schedules. Moreover, as companies rationalise warehouses, trucks are increasingly used as storage space with accompanying problems if a truck runs late. As a result, efficiencies are improved and inventory costs are reduced because companies only receive goods on an as-needed basis.

However, if truck drivers fail to meet the set times, the transport operator may have to compensate the client for delays incurred. The stress put on the drivers is aggravated by the constant reporting of updates on drivers’ and trucks’ positions via tracking devices or cell phones.

by law, but going so far as to breach the law, because of the low rate of enforcement. The reduced nine hours of rest is becoming the norm and a typical element of a drivers’ roster. This is mainly due to cost efficiency and profit maximisation on the part of the transport operators.

Studies and ex-post evaluation of European legislation have revealed issues concerning the effectiveness of legislation in respect of the driving, working and resting times of professional drivers (European Commission 2017). The main problems with the legislation were identified as matters of weak application and enforcement in the Member States. Differences between the States concern the interpretation of legislation, definitions of infringements, levels of fines and sanctions, and discrepancies in inspection and enforcement practices. The Enforcement

Directive 2006/22/EC establishes minimum levels of roadside checks and inspections on the premises of transport companies to be carried out every year by Member States, but our analysis shows that there are major problems with the thoroughness of inspections. Several interviewees, including, in particular, inspectors from the highway police attending the ETF Project workshops, pointed to a variety of widely known infringements, especially regarding driving and working time. Our own data analysis has notably shown that the prevalence of fatigue is significantly higher in drivers from companies where working time is not documented, or not documented well (see Chapter 3). Drivers who reported that working time is documented rigorously were less often affected by driver fatigue.

In general, the most frequent violations

concern working time, and break and rest periods, followed by unpaid working hours and manipulation of digital tachographs or data sheets (Tsamis 2018; Voss/Vitols 2019).

Tachograph fraud

Tachograph records are compulsory in all vehicles weighing more than 3.5 tonnes that are being used for commercial benefit. A growing problem is tachograph fraud in trucks, because frauds are becoming more sophisticated, with adaptations of circuit boards and software to make enforcement of driving times and rest periods more difficult to detect. On the positive side, EU Regulations have laid the pathway for the introduction of a new-generation “smart tachograph” to eliminate the most serious forms of tampering and other offences. On the negative side, however, the level of sanctions against violations is not uniform across Europe; types of penalties and the size of fines vary greatly (Pastori/Brambilla 2017). In some countries, sanctions are so ineffective that they have no influence on a company’s decision whether to comply with the law or not.

BREAKS AND REST TIME

Breaks and rests can prevent fatigue. Breaks are commonly known to reduce and prevent stress and to help to maintain and improve performance. Rest is an important recovery time allowing drivers to regenerate after long immersion and exhaustion. A failure of rest can lead to chronic fatigue. In the road transport sector, a fundamental problem regarding breaks and rest periods is that, despite the legal working time definition specifying the activities that are covered by working time, not all work activities are taken into account by the operators or included in the working time calculation (or paid for, for that matter). Many drivers are instructed to record time spent on work activities as break or rest time.

In the case of non-unionised drivers, often the only time paid is the time spent actually driving the vehicle. This is almost the norm in the case of drivers from central and eastern Europe, as the targeted interviews conducted for the project revealed.

Shortened breaks

“Every single minute is used up when creating a timetable, regardless of traffic conditions, weather or passenger volume.”

(Austrian bus/coach driver)

“The resting conditions during breaks are terrible. At certain bus stations you are not even allowed to park the bus for more than an hour. If there are resting facilities, they do not provide suitable conditions for relaxation. It’s mostly a small crowded room with a couple of tables and chairs, noisy, no food service.”

(Hungarian coach/bus driver)

According to the EU regulation, there must be at least 45 minutes of break for every four and a half hours of driving. This can also be split into separate breaks of 30 and 15 minutes. Our analysis shows, however, that breaks are not being taken properly. 72% of the coach and bus drivers and 67% of the truck drivers who responded to our survey identified too few breaks as a very important or important risk factor contributing to fatigue. Drivers also report that breaks are not a true period of relaxation.

Several factors prevent breaks being used effectively for recuperation. Drivers reported often having to use the breaks for other work activities such as finding a parking space, communicating with passengers or clients, and studying the route. Some bus and coach operators allow their drivers to sell drinks and snacks during their breaks to supplement their income; and, since the drivers’ pay is so low, this is an incentive to forego the break. For these reasons, even though coach drivers stop relatively often for breaks when passengers are on board, this does not lead to relaxation. Truck drivers, moreover, report that they are regularly contacted by their employer or dispatchers during breaks, often with the aim of building up pressure to complete a transport faster, or to meet tight schedules.

Table 3: Tasks performed by bus and coach drivers during rest times

Tasks	Percentage of drivers answering "always" to the survey question, whether they perform these tasks during rest times
Cleaning the coach	58%
Studying the route (identifying parking areas, tolls, etc.)	56%
Finding a parking space for the coach	46%
Loading/unloading luggage	46%
Pick-up/drop-off group from hotel/station	31%
Assisting passengers with personal problems	28%
Providing sightseeing advice to passengers	26%
Selling drinks/snacks	19%
Selling tickets	13%

Source: Turnbull (2018)

Schedule pressure

Breaks may not be taken at all, or at least not at full length. The perceived pressure to be on schedule plays a major role (see also Chapter 5.1 on mental overload). Often the time allotted in passenger transport schedules, or by shippers or receivers for a road freight transport trip, is too tight. Tight schedules and scheduling demands were named by 81% of bus and coach drivers and 75% of truck drivers in our survey as very important or important risk factors for fatigue. Our interview partners criticised the fact that the schedules take no account of delays that occur, for example, because of traffic congestion or passenger volume. In a Swedish study of bus drivers from 2017, 27% of respondents did not think that driving times were calculated realistically. About 18% did not arrive on time for their breaks, which meant that they could not benefit from their break to the extent stated in their schedule (Dahlman/Anund 2020). With truck drivers, time pressure arises from the customer's time window for a delivery. Truck drivers must commonly observe a set delivery time – "just-in-time delivery" – instead of a broader time window (see Box 4 on page 30).

There is general pressure from the employer to carry out transports faster and more cost-effectively. Work pressure was given as a very important or important reason for fatigue by 78% bus, coach and truck drivers responding to our survey.

An important infrastructural issue our research identified is the great difficulty drivers have in finding a suitable place to rest. There is a general lack of rest areas for large vehicles throughout Europe. This issue is especially problematic for truck drivers, who often face the problem of overcrowded motorway parking spaces. For bus drivers the problem arises when they cannot park the vehicle at a bus stop or can only do so for a limited time. In our survey, 63% of the bus and coach drivers and 83% of the truck drivers identified the shortage of rest areas as a very important or important factor contributing to fatigue. This problem was particularly associated with prolonged journeys, which in turn go hand-in-hand with the problems of long working hours, short breaks and even infringements of working and driving time regulation. In addition, the design of rest areas was seen as problematic. Besides being exposed to noise nuisance – for example, from unshielded highways and impulse noise (slammed car doors) – rest areas lack amenities such as quiet seating areas or recreational facilities.

INSUFFICIENT RESTS

"In the nine hours of rest, I have to clean the bus, get home etc ... I only get four to five hours of sleep."

(Dutch bus/coach driver)

"9 hours daily rest when not sleeping in the vehicle is not enough. Many drivers spend up to two hours a day commuting. The office is constantly pushing for you to do 60 hours a week over 5 days."

(British truck driver)

According to EU regulation, daily rest periods must be of at least 11 hours, with the exception of a reduction to 9 hours a maximum of three

Box 5: Obstructive Sleep Apnoea Syndrome (OSA)

Obstructive Sleep Apnoea Syndrome (OSA) is a condition in which breathing frequently stops or is substantially reduced on a regular basis throughout the night. Each instance of apnoea is associated with a partial awakening as breathing is restored, and these consecutive awakenings lead to a lack of restorative sleep. Surveys show that bus, coach and truck drivers have a higher rate of sleep disorders (Kim *et al.* 2017; Meuleners *et al.* 2015; Vennelle/Engleman/Douglas 2010). For example, Braeckman (2011), in a study of 474 truck drivers from Flanders, found that 22% of them had a higher risk of OSA. Other studies estimate that between 3% and 7% of the general adult population suffer from OSA; but the corresponding incidence for professional drivers is between 26% and 50% (Talbot/Filtness 2016). The Italian trade union FILT CGIL reports, on the basis of a survey of 570 truck drivers on sleep, health and sickness, that more than 20% of the drivers experienced sleep complaints (FILT CGIL 2017). In our survey, 73% of bus and coach drivers and 69% of truck drivers reported sleep disorders as a relevant risk factor. Sleep disorders are not always checked for during drivers' regular medical check-ups.

times a week. As we have seen, operators make common use of this exception. In addition, various work-related tasks are often carried out during rest time. A 2018 study on the working conditions of 698 coach and bus drivers in Europe lists a wide range of work activities that drivers "always" perform within their rest time (see table 3).

Commuting time

The time drivers spend travelling to and from vehicles also often occurs within the rest periods. Many drivers spend a lot of time every day commuting. Non-resident drivers from some European countries sometimes have to spend days in a minibus to get to the job site before their actual assignment begins. Not enough time to rest was reported by 82% of bus and coach drivers and 74% of truck drivers in our survey as being a very important or important risk factor for driver fatigue.

Shortage of rest and loss of sleep

In addition, long stretches of work without days off are mentioned as a relevant cause of fatigue. In our survey, 85% of bus and coach drivers and 78% of truck drivers identified series of long working days without days off as an important or

very important cause of fatigue. EU regulation requires at least one 45-hour rest and one 24-hour rest in any two-week period – with the exception of occasional international coach tours which fall under the "12-day derogation", meaning that the driver can be required to drive twelve days without any days off. The newly adopted driving and rest time rules make it possible too for international truck drivers to drive three weeks with only two days off.

Short rest time is associated with sleep deprivation (Filtness *et al.* 2019). Studies of fatigue are often oriented towards sleep research, and sleep deprivation has been identified as one of the main risk factors causing fatigue. As mentioned in Chapter 4, sleep-related factors are a significant source of driver fatigue. In studies, the most frequently mentioned causes of fatigue are a lack of sleep, poor quality sleep and sleeping disorders, as well as sleep demands induced by the circadian cycle or internal body clock (Anund *et al.* 2016; Belenky *et al.* 2012; Braeckman *et al.* 2011; ETSC 2011). Long working shifts and short sleep periods significantly increase the risk of momentarily falling asleep at the wheel (Perttula/Ojala/Kuosma 2011; Unite 2019; Verpraet 2006). In our survey, 84% of bus and coach drivers and 79% of truck drivers said that not enough time to sleep

Box 6: The ferry/train derogation allows the disruption of the rest time

The EU rules stipulate that, during a rest, a driver shall be able, according to Article 4(f) of the Regulation (EC) No 561/2006 on driving times and daily and weekly rest periods, to dispose freely of their time. However, Article 9 (1) deals with the situation in which a driver accompanies a vehicle being transported by ferry or train, and in this context provides for certain derogations. When a driver is travelling by ferry or train, provided that they have access to a bunk or couchette, the driver can take their break or rest on the ferry or train. This derives from the wording of Article 9(2) which stipulates that any time spent travelling “shall not be counted as a rest or break unless the driver is on ferry or a train and has access to a bunk or couchette”. The ferry or train rule thus derogates from the provision whereby a “rest” constitutes “any uninterrupted period during which a driver may freely dispose of his time”.

A regular daily rest period of at least 11 hours taken on a ferry or a train may be interrupted a maximum of two times. The total time of these two interruptions may not exceed one hour.

With the new rules adopted in July 2020, companies, for the purposes of getting vehicles on or off a ferry or train, can make drivers interrupt not only their daily rest but also their weekly rest, notably the reduced rest (minimum 24 hours), and their normal weekly rest periods (45 hours and more). The only difference between the latter two is that, when rest is taken as part of the normal weekly rest, the ferry journey must be of at least eight hours' duration. The ferry/train derogation can only be used when the driver has access to a bunk bed or couchette. However, a grievance highlighted by drivers participating in our research was that they often lack appropriate rest facilities during such journeys. On ferries, for example, drivers often do not have a reserved cabin, and on trains, compartments have to be shared with other people, which makes it difficult to get a restful sleep. On a four-hour ferry journey, for instance, the actual time spent in a couchette – if any – is usually reduced by half, as it takes time to check in, and then the driver has to vacate the cabin long before the end of the journey, to allow ferry staff to clean and prepare the cabin for the next crossing.

was a very important or important factor contributing to fatigue. Lack of sleep is determined by long periods awake. The average person needs 8 hours of sleep per 24-hour cycle. Multiple studies have shown that getting less than the 8 hours required – as often is the case with bus, coach and truck drivers – results in sleep deprivation leading to fatigue (Akerstedt/Philip 2018; Thiffault 2011; Unite 2019).

Poor quality of rest

The quality of rest can also be a problem. In the 2017 Swedish survey of bus drivers, 22% of

respondents did not feel rested when they got behind the wheel at the start the day (Dahlman/Anund 2020). The quality of sleep can be an important factor (Braeckman et al. 2011; FILT CGIL 2017; Filtness et al. 2019). Poor quality of sleep was reported as an important or very important factor contributing to fatigue by 82% of bus, coach and truck drivers in our survey. The quality of sleep is impaired by interruptions and by unfavourable sleeping conditions. Sleeping disorders, such as Obstructive Sleep Apnoea Syndrome (OSA) can lead to interrupted sleep (see box 5 on page 33)

The EU's "ferry/train derogation" allows the disruption of drivers' rest time when embarking onto, or disembarking from, a ferry or train, with the corresponding negative consequences for the drivers' rest (see box 6). 77% of bus and coach drivers and 79% of truck drivers in our survey identified interrupted sleep as an important or very important factor contributing to driver fatigue.

Bad sleeping conditions

With regard to sleeping conditions, 67% of bus and coach drivers and 65% of truck drivers identified unfavourable sleeping conditions as a factor contributing to driver fatigue. For example, with multiple crewing, operators commonly consider the first 45 minutes that a driver spends away from the wheel, as a break, no matter where the driver actually is. As a result, a driver often has to take the break buckled-up in the passenger

seat while the vehicle is in motion. Truck drivers, in particular, who often have to spend the night at rest areas, complain that the poor design of parking spaces as well as uncomfortable environmental conditions are factors contributing to the poor quality of sleep (see also Box 7). Sleeping in the cabin is impaired by the lack of air conditioning and by noise from unshielded motorways. Many drivers find the rest areas unsafe – they are often the scenes of theft. Truck drivers reported that having the feeling that something could be stolen kept them from sleeping deeply in the cab. Truck drivers also referred to a specific problem with refrigerator trucks, which are designed to carry perishable freight at specific temperatures. For this purpose, they are sometimes equipped with a mechanical refrigeration system powered by a small displacement diesel engine. This can be extremely noisy. Truck

Box 7: The problem of uncomfortable environmental conditions

"The air conditioning runs on battery, but after 4–5 hours the battery is so low that I switch it off, otherwise the engine could not be started."

(German truck driver)

"A night spent [sleeping] in the summer without AC is a lost night."

(Portuguese truck driver)

Working in harsh and uncomfortable environmental conditions can contribute to fatigue (NSW Mine Safety Advisory Council/NSW Government 2009; Phillips/Sagberg/Bjørnskau 2016). In road transport, uncomfortable environmental conditions include those affected by heat, cold, noise and mechanical vibrations inside the vehicle as well as by external factors, such as bad weather, poor visibility, poor roads and high-density traffic. Extreme temperature, especially heat, was named by 78% of bus and coach drivers and 73% of truck drivers in our survey as a risk factor for fatigue. Heat was also mentioned as a cause of fatigue by almost all interview partners, as air conditioning in the vehicles is often fails to regulate the temperature well. Bus and coach drivers further pointed out that their vehicles are usually equipped with very large windows to enhance the passenger comfort. However, this results in drivers being much more exposed to the sun. Out of consideration for the passengers, windows usually cannot be opened when driving. Truck drivers explained that a running engine heats up the cabin even further, adding to the heat from outside in summertime. In addition, air conditioning shuts down automatically after only a few hours. Heat is also a key factor contributing to the poor quality of sleep experienced in the vehicle cab. In addition, mechanical vibration and noise nuisance can cause discomfort leading to fatigue.

drivers report that refrigerator trucks at rest stops kept not only the drivers of these trucks but also other drivers parked in the vicinity from getting a comfortable rest.

UNPREDICTABLE AND IRREGULAR WORKING SCHEDULES

“I don’t know if I am working tomorrow or not. There is no scheduling: if they [the employer] don’t call until four o’ clock, you know you are off the next day. It might be that extra jobs come in on that day and that’s why they [the employer] don’t commit to schedules.”

(Belgian bus/coach driver)

Feeling fatigued is commonly linked to the body’s circadian rhythm (European Commission 2018b) – the internal biological clock that coordinates the physiological priorities for daily activities. The role this plays in driver fatigue involves what is known as the time-of-day effect. The human body has a greater need for sleep at certain times in a 24-hour cycle. At these times there is a natural tendency to sleep and, if this is suppressed, a sleepy feeling occurs. Night work and irregular work (and sleep) patterns conflict with the natural biological cycle and consequent sleep needs (European Commission 2018b; Parkes/Gillan/Cynk 2009; Thiffault 2011). The fixed programming of the human body clock is also the key reason why it can be harder to sleep during the day than at night. In our survey,

driving at night was reported by 70% of bus and coach drivers and 71% of truck drivers to be a relevant factor contributing to driver fatigue. In Chapter 4 it was pointed out that there is an association between the frequency of accidents and the circadian rhythm. This rhythm also plays a role in relation to irregular working schedules. Our analysis found that bus, coach and truck drivers are less likely than workers in most other occupations to work the same schedule each day. Irregular working schedules, rotating shifts and frequent changes in work-rest schedule go against the fixed programming of the human body clock (Akerstedt/Philip 2018).

Another problem our research noted is receiving short notice of shifts. This usually results from operators’ wanting to be as flexible as possible, and to avoid additional costs when employees are called in on days off, as well as from pressure to accept urgent loads and transports from customers. It is quite common in the transport sector for bus, coach and truck drivers only to be informed of their next assignment during the afternoon of the previous day. This does not allow the drivers to do any planning, and negatively affects the circadian cycles, causing instability in sleep patterns. The next shift may even begin during the coming night, which makes it impossible to get adequate sleep before the job starts.

Studies also show that shift work – especially split shifts (where the working day of a single driver is split into two periods) – increases sleepiness while driving (Ihlström/Kecklund/Anund 2017).

6

PREVENTION AND COUNTERMEASURES

Countermeasure strategies to prevent driver fatigue have received considerable attention over the past years, and the literature on the prevention of fatigue is quite extensive (Anund *et al.* 2015; ETSC 2011 and 2013; European Commission 2018b; Filt-ness *et al.* 2019; Goldenbeld 2011; Phillips 2016; Thiffault 2011). However, a vast proportion of the literature focuses primarily on the detection of microsleep through general road safety strategies, such as a safe road infrastructure (such measures as median barriers, lanes with audio-tactile feedback when crossed – hard shoulder rumble strips) and technical solutions, such as vehicle safety crash avoidance technologies and fatigue-detection technologies (Administré-Fodor/Jost 2020). While these measures can be useful in reducing the worst consequences of fatigue, they do not actually prevent fatigue. In fact, this approach is largely based on considering fatigue when it is too late, rather than on identifying its real causes, and eliminating its consequences by preventing fatigue from occurring. Understanding the (real) causes is crucial for effectively preventing, detecting and counteracting fatigue.

Solutions found through desk research can be broadly grouped into several categories, including self-administered countermeasures, management interventions, road infrastructure measures, legislation and enforcement, fatigue-detection technology and publicity campaigns (see Box 8 on page 38).¹³

Countermeasures are as diverse as the causes of fatigue. With regard to the definition of fatigue (see Chapter 2) – a significant question is whether driver fatigue is now considered purely “fatigue”, or as a manifestation of “sleepiness”. While fatigue in the narrow sense results from physical demands and conditions, such as the forced posture while driving, or monotony,

Table 4: Factors rated very important or important as countermeasures to prevent driver fatigue (survey results)

Countermeasures	Bus/coach drivers	Truck drivers
Self-administered countermeasures		
Stop and take a break	87%	89%
Take a nap	73%	80%
Other countermeasures		
More/better resting locations for drivers	87%	93%
Better road infrastructure	78%	81%
Increase employers' awareness of the consequences of fatigue	80%	76%
More consistent enforcement of legislation	81%	73%
More education on the effects of fatigue on drivers]	76%	70%
Stricter legislation on rest/driving times	81%	68%
Public awareness campaigns on driver fatigue	75%	68%
Clear safety rules and guidelines for drivers from employer	77%	67%
Employer's own fatigue management plan	70%	61%

Source: own survey

13 See also: Dorn (2017); Fletcher *et al.* (2005); Société de l'assurance automobile du Québec (2011)

Box 8: Common countermeasures found through desk research

- **Legislation and enforcement:** initiatives to enforce regulation and to provide a mechanism for the effective implementation and enforcement of control measures (working time, rests and breaks)
- **Self-administered countermeasures:** rest/sleep, caffeine, opening the window/ turning on the air conditioner and listening to music
- **Education:** Educating professional drivers on aspects of fatigue
- **Timing of work and schedule design:** work and shift planning, hours of service, breaks and naps, work schedules around circadian patterns, minimum rest periods between shifts
- **Fatigue Risk Management, or specific company management interventions:** safety management systems, risk assessments and mitigation strategies, company culture, monitoring of actual hours worked
- **Fatigue-detection technology:** vehicle-based detection and warning devices, e. g., devices based on measurements of eye movements and driver behaviour (including steering and lane deviations)
- **Road infrastructure measures:** rest areas, design of roads (rumble strips);
- **Publicity and awareness-raising campaigns**

sleepiness results from a lack of sleep. This conceptual division results in divergent countermeasures. Fatigue can be reduced by taking breaks, but sleepiness can only be remedied by sleep. The need to focus on the sources of fatigue to find effective countermeasures is again evident in respect of mental or physiological underload and overload, which require completely opposite countermeasures. In addition, work-related fatigue can be best managed at an organisational level, while non-work-related factors vary considerably between individuals and are best managed at an individual level. It is interesting to note that very little research has been done in the way of evaluating actually operating countermeasures against driver fatigue. It is consequently often difficult to draw conclusions concerning the effectiveness of these measures (Filtner *et al.* 2019).

The results of our analysis in Chapter 5 show that working conditions play a major role in

determining driver fatigue. However, countermeasures considered in the literature typically do not include any consideration of changing working and employment conditions. The literature largely focuses on self-administered countermeasures. These transfer the responsibility for preventing driver fatigue to the drivers themselves. Given that fatigue is mostly caused by poor working conditions, drivers are hardly empowered to take action to remedy their own fatigue – whether through prevention or through countermeasures. Studies have found that, in spite of all the drivers' knowledge of the risks, of the significance of sleep, and of the importance of taking a nap, most drivers continue driving even when they are conscious of feeling sleepy (Nordbakke 2004; Nordbakke/Sagberg 2007). Because of the chain of command, drivers may have only limited possibilities of influencing the design of the trips they make, and thus of taking measures to prevent fatigue. Moreover,

not all the countermeasures against fatigue that are common in other sectors of employment are available to bus, coach or truck drivers, who face a more restrictive working environment.

In our survey we asked participants to identify important countermeasures to prevent driver fatigue in road transport, out of a list of 19 options. Table 4 (on page 37) lists the countermeasures that are considered to be an important or very important factor.

The following section focuses on countermeasures aimed at the main causes of fatigue identified during our research (see Chapter 5). The selection reflects the results of our survey and interviews, as well as the outcome of the workshops and the seminar. These countermeasures lie, variously, within the remit of drivers, operators the EU and the Member States.

It must be kept in mind that driver fatigue is a very complex issue. Most often, multiple different causes play roles in causing it. Instead of implementing countermeasures to address a single aspect of the problem, a more inclusive, holistic approach is often needed to reduce driver fatigue.

COUNTERMEASURES FOR DRIVERS

“You cannot just stop the bus when you are tired. There are passengers on board and timetables to follow.”

(British coach/bus driver)

“Living on coffee and energy drinks – is this really healthy?”

(Romanian truck driver)

Many guidelines, training-courses and road safety campaigns highlight self-administrated countermeasures against fatigue. The literature, too, points to a number of countermeasures that can be self-administered, such as, for example, drinking caffeine in the form of tea, coffee, cola or an energy drink. However, a broader range of self-administrated measures is used by drivers, with varying degrees of effectiveness – for example,

opening the window, turning on the air conditioner and listening to music. One study discusses the effectiveness of these measures, and reaches mixed conclusions (Nordbakke/Sagberg 2007). Our survey results show that most respondents know whether or not individual countermeasures are effective; and they generally do not see drinking caffeine, letting in fresh air or listening to the radio as effective ways of increasing alertness.

Rest that includes sleep

Studies show that the most effective and efficient remedy for fatigue is rest that includes sleep (Société de l'assurance automobile du Québec 2011). The participants in our survey, too, strongly emphasise that sleep is an effective countermeasure against fatigue. 73% of bus and coach drivers and 80% of truck drivers saw “take a nap” as an important or very important measure for reducing fatigue. However, as shown in Chapter 5, the basic requirements for sufficient sleep depend on the working conditions, and these can hardly be influenced by the bus, coach and truck drivers themselves.

Another important measure to counter fatigue is seen in “stopping and taking a break”. 87% of bus and coach drivers and 89% of truck drivers in our survey rated taking a break as a very important or important countermeasure. Although taking a break was assessed to be effective, drivers argued during our research work that it was not a prevalent countermeasure, for the reasons listed in the previous chapter. Bus and coach drivers, in particular, are not free to take a break or nap whenever they need to, as they have passengers on board and strict time schedules to follow. This severely limits the ability of bus and coach drivers to prevent fatigue. The drivers and trade union representatives participating in the workshops and interviews pointed out, however, that taking a nap can only be regarded as a short-term solution, and not as a real remedy for chronic fatigue.

Education

Educating professional drivers on aspects of fatigue is considered as a prevention strategy in various studies (Dorn 2017; ETSC 2011;

Box 9: Countermeasures targeting drivers

- Adequate sleep and sufficient breaks
- Education to increase the drivers' awareness of driver fatigue
- Frequent health screening, including checks to detect sleep disorders

Source: own compilation on the basis of the survey results, targeted interviews, workshops and the seminar

Pylkkönen *et al.* 2013). It has been suggested that drivers should be educated on various aspects of driver fatigue, such as the physiology of fatigue, management strategies, safety implications, and effective countermeasures. Our survey shows that 76% of bus and coach drivers and 70% of truck drivers considered that more education on the effects of fatigue on drivers would be a countermeasure helping to prevent fatigue. However, our interviews revealed that any consideration of fatigue management in driver training and education is minimal, if not non-existent. It should be said that special education for drivers can be useful in increasing drivers' awareness of fatigue, and can help them judge more reliably their own level of fatigue-related impairment.

Similarly, road safety public awareness campaigns have typically been relied on to prevent driver fatigue in the general public. Public awareness campaigns on driver fatigue were considered to be an important or very important factor in combating fatigue by 75 % of bus and coach drivers and 68% of truck drivers in our survey. However, several critical studies have rated the effect of such educational interventions as being of limited value (ETSC 2010; Pylkkönen *et al.* 2013). Failing to address the real underlying causes of driver fatigue is seen as one of the reasons why training courses on fatigue do not necessarily improve the alertness of drivers.

Health screening

Regarding sleep disorders, our research shows that bus, coach and truck drivers would like better regular health screening. The targeted interviews pointed to the conclusion that the medical check-ups carried out every five years are often superficial, and mostly do not check either for sleep disorders or the reasons underlying them. Interview partners suggested that medical checks should instead be carried out every year. Since the therapy for sleep apnoea is accompanied by a treatment period of about one month, it was requested that the drivers' income should be secured during this period

COUNTERMEASURES FOR EMPLOYERS

“There is no example of good practice in the sector. I think it is the only industry that doesn't have a program for the problem, and that has to do with the fact that the customers and the bosses don't care..”

(Belgian truck driver)

Hours, days and pay

Cumulative fatigue increases with the number of hours worked, so drivers taking part in our research work suggested that drivers' working hours should be reduced. However, it was also generally noted that total working hours can only be reduced if the salary is increased at the same time, so that there is no loss of income for the drivers, who often work on low pay. On another point, the interviewed drivers stated that increasing salaries would also reduce the financial incentive that leads some drivers to work long hours. Drivers strongly expressed the view that companies must reduce the number of consecutive days that need to be worked. The use of extended hours should also be eliminated, or restricted to emergencies and other exceptional circumstances. In road freight transport, the working week should be limited to 40 hours. Concerning long journeys, multiple crewing should be

mandatory. In the opinion of the drivers participating in our project, considerations of working time, especially with long hours of work, also need to take into account the drivers' commuting time. The EU rules are very clear on what is and what is not considered working time when drivers commute to take charge of their vehicles, but these rules are rarely complied with.

Documentation of working time

Above all, employers must meet their legal obligations to record and document the actual hours worked. As Chapter 3 showed, the way working time is documented has a bearing on fatigue. It must be ensured that all work-related tasks (especially loading and unloading, waiting time, availability time) are properly recorded and paid for. The proper documentation of all work-related tasks would also bring about proper payment for these tasks, and lead to an increase of the drivers' income.

The management of working time affects drivers directly, affecting their opportunities to sleep, rest breaks, and length of working day. During the interviews and the workshops, it was pointed out that reasonable work scheduling should avoid or limit night driving, short daily rests and long work shifts.

Ensuring necessary rest and sleep

As we have seen in Chapter 5, inadequate quality and quantity of sleep are significant causes of fatigue. Work schedules should be designed around circadian patterns and the employee's body clock. Night driving should be avoided as far as possible in the transport sector. Drivers taking part in our research even recommended considering the imposition of restrictions on night driving. Regarding rest time, interview partners suggested an increase in the length of rest between shifts to allow for a full recovery between work periods. There should be a minimum of 12 hours rest between shifts. Longer daily and weekly rest periods would allow drivers enough time for travel to and from work, to recover physically and to socialise. Breaks should allow for naps, and the management and the client should abstain from

contacting drivers during breaks. In addition, it should be made possible to extend the length of breaks as needed.

Reasonable scheduling

A very important countermeasure mentioned by the drivers involved in our research, in the context of working-condition-related causes of fatigue, was reasonable work scheduling that reduces the occurrence of irregular schedules and late notification of shifts.¹⁴ Shift rosters, for example, should be set well ahead of time, and sudden changes in them should be avoided, to allow drivers to plan. In addition, late and night shifts should not change several times a week. Moreover, it is important to focus on the role of managers and dispatchers in improving compliance with the working time regulation. One step in this direction would be to set up realistic delivery schedules and timetables, so that drivers do not feel pressured to stretch the limits. Driving schedules need to be adapted to actual driving time, but also need to leave extra room for unforeseen delays.

Reduction of physical labour

Another focus identified by workshop participants, and in the targeted interviews, was the reduction of physical labour, since physically demanding work also leads to fatigue. For example, it could be decided that drivers no longer have to be available for loading and unloading.

Fatigue risk management strategies

Furthermore, to prevent driver fatigue, it was suggested that operators should develop a Fatigue Risk Management strategy, comprising, for example, safety management, risk assessments and mitigation strategies tailored to company policies, roles, and documents (Phillips 2016). However, few organisations currently manage work-related fatigue in any systematic or quantitative manner. This project was unable to identify any road transport operator working with such a concept. It should be noted that Fatigue Risk

¹⁴ See also: Wang S./Wu K. (2019)

Box 10: Countermeasures targeting employers

- **Fatigue Risk Management strategies** to address the problem of driver fatigue and implement countermeasures to prevent and combat fatigue
- **Compliance with working and driving times rules** (including documentation of all work-related tasks, and travel to and from the vehicle, especially for non-resident drivers)
- **Reasonable work schedules** to avoid or limit night driving, short daily rests and long work shifts;
- **Regularity in work scheduling** to reduce irregular and unpredictable work by providing a longer period of notice of shifts
- **Removing the pressure from drivers to be punctual**, for example, by reducing just-in-time-delivery
- **Higher pay** to reduce the appeal of pay incentives to work longer hours
- **Reduction of physical labour** to reduce physical overload
- **Well equipped vehicles** (for example, with proper air-conditioning);
- **Acknowledgement by clients of responsibility** to help prevent driver fatigue.

Management is already obligatory in other transport sectors. For instance, in aviation, Fatigue Risk Management is required from every airline in the context of the European Regulation of Flight Time Limitation (83/2014) (European Cockpit Association 2014). In response to our survey, drivers called for transport operators to deal more proactively with the issue of driver fatigue. 70% of bus and coach drivers and 61% of truck drivers considered a fatigue management plan for their own company to be very important or important. In addition, increasing employers' awareness of the consequences of fatigue was reported by 80% of bus and coach drivers and 76% of truck drivers participating in our survey as an important countermeasure to prevent driver fatigue. This should be accompanied by guidance for drivers. Clear company-wide safety rules and guidelines for drivers were seen by 76% of bus and coach drivers and 67% of truck drivers as very important or important factors in preventing driver fatigue.

Upgrading fleets

A further point mentioned during our research work was that many operators need to update their fleets. Better equipped vehicles (for example, with proper air conditioning) make for better working conditions.

Easing delivery pressure

Interview partners and workshop participants pointed out that customers, too, have a responsibility for the way the sector functions. It was stated that customer companies, for example, foster ruinous price competition in the transport industry through their prioritisation of costs before quality and safety. In road freight transport, just-in-time-delivery exerts pressure to be on time. To prevent fatigue and to relieve the pressure drivers are under to be punctual, customer companies should provide a wider window for delivery times. In the opinion of truck drivers, just-in-time-journeys should be severely restricted. Moreover, the contractual relationship

between operators and contractors should be regulated through the adoption of contracts that permit **compliance with working time regulations** to be properly verified. Strengthening the **enforcement of the liability clause** (article 10 of Regulation (EC) No 561/2006), and making clear provisions for its enforcement, could eliminate some of the pressure of just-in-time deliveries.

COUNTERMEASURES FOR THE EU AND THE MEMBER STATES

“A group of employees with little confidence is being squeezed out to maximise the profits of the employers.”

(Participant at the workshop on driver fatigue in passenger road transport)

“Companies would rather pay fines. [...] Drivers have a master or visa card to pay the fines and then they are gone again. If they get inspected once in a while it doesn't matter.”

(Police inspector at the workshop on driver fatigue in road freight transport)

“I can't remember the last time I was inspected.”

(Portuguese truck driver)

The growing economic pressure that affects working conditions in the road transport sector is mostly the result of increasing competition as a result of deregulation. Most operators are unable to escape from this economic competition, or do not want to. Individual workers have even less influence. In the course of our research, some drivers mentioned that they were afraid to demand even basic workers' rights, as there seemed to be a constant threat of dismissal. Trade unions are also confronted with an ever-growing struggle against social dumping. Results of the targeted interviews and the outcomes of the workshops indicate that a common set of stronger legal

regulations could reverse the downward spiral that has been set in motion by unfair competition.

Strengthening regulation

Regulation 561/2006 already provides uniformly applicable rules to limit driving time and requires drivers to take minimum breaks and rest periods. The regulation should be extended further, to cover the entire sector, including the types of operations and the types of commercial vehicle that are currently not in scope. A general conclusion of the workshops was that policy makers should be tightening the working time and driving and rest time rules to eliminate the causes of fatigue more effectively.

Cumulative fatigue increases with the number of hours worked, so drivers participating in our research work suggested that there should be a co-ordinated approach to regulate working time in order to reduce working hours in general and to eliminate the use of extended hours. In addition, sufficient time for daily and weekly rest needs to be guaranteed. As has been mentioned, a reduction of working time has to take into account the negative effects on the pay of the drivers, who need to be compensated.

Scrapping the ferry/train derogation

With regard to the ferry/train derogation, drivers expressed themselves strongly in favour of scrapping it completely. 81% of bus and coach drivers and 68% of truck drivers in our survey identify stricter legislation on rest or driving times as a very important or important countermeasure to prevent driver fatigue.

Strengthening enforcement

Besides strengthening regulations on working time and rests, a key countermeasure against fatigue identified by the interview partners and workshop participants was the enforcement of the current regulations through inspections and sanctions. Adequate enforcement was considered to be vital in promoting compliance with the regulation. As described in Chapter 5, infringements of the regulations are frequent. Inspections are rare and many drivers stated

Box 11: Countermeasures targeting legislation and enforcement

- **Extend the regulation on driving and rest time**, to cover the entire sector, including the types of operations and types of commercial vehicle that are currently not in scope.
- **Scrap the ferry/train derogation, completely**
- **Strengthen enforcement** (with more and better inspections)
- **Impose severe penalties for breaking the law**
- **Provide better, well designed parking spaces and rest areas.**

Source: own compilation on the basis of the survey results, targeted interviews, workshops and the seminar

during our research work that they had not been checked for years. Interview partners and the participants of the workshops emphasised the need for assurance that the Member States respect the requirements concerning the number of checks to be held, and recommended that the minimum number of checks should be increased, as more frequent checks contribute to improved compliance.

81% of bus of the coach drivers and 73% of the truck drivers participating in our survey reported that more consistent enforcement of legislation would be a very important or important measure against fatigue. The shortage of checks is largely due to an unwillingness on the part of the Member States to tackle the problem, also manifested in the lack of inspectors. Our analysis, moreover, shows that there are major problems with the depth of the inspections. The introduction of new generations of

smart tachographs is a first step in improving the technology for monitoring compliance. The smart tachograph – available currently in a version 1 and, from August 2023 in an improved version 2 – is better in respect of both the amount and the quality of data it records, and it reduces the possibilities of anyone tampering with the equipment. With the improved smart tachographs, roadside enforcement officers will in future be able to scan the data of passing vehicles wirelessly, without having to stop them, and thus to detect some offences. More resources should be given to inspectors, beyond those that are already mandatory by law.

Increasing penalties

As a corollary of enforcement, penalties can strongly influence behaviour towards compliance. To improve companies' respect for the regulations, it is important that the sanctions should be severe enough to deter the companies from committing violations. As drivers involved in our research pointed out, despite the fact that the EU directives clearly make operators responsible for breaches of driving and rest time rules, in some countries, it is the drivers who are held liable for violations of these rules, although they may have had little influence over whether or not a violation occurred.

Improving the infrastructure

Improving the road infrastructure is another key factor in countering driver fatigue. In our survey, 78% of bus and coach drivers and 81% of truck drivers identified better road infrastructure as a key countermeasure for combating fatigue. In particular, the number and the design of roadside rest facilities were seen as very important considerations. In our survey, 87% of bus and coach drivers and 93% of truck drivers agreed that having more and better rest facilities would be very important or important countermeasures against driver fatigue. The findings examined in Chapter 5 show that particular attention should be given to providing safe and appropriate roadside rest facilities. Regarding the safety aspect of parking areas, the problem could be

solved by deploying security guards. As for noisy rest areas, it was suggested that a soundproof wall could be set up to separate parking areas from the highway. As explained in Chapter 5, refrigerator trucks pose a particular challenge. Replacing refrigeration units with quieter models

may help solve the problem. Units operating on electricity or with an electric option are quieter than engine-driven units. In general, older refrigeration equipment can be particularly noisy. In addition, rest stops should provide better fitness and recreational facilities.



7

CONCLUSION

“All actors need to work together [in combating driver fatigue], if we want it to be a success story. The operating companies have a big responsibility, so do the customers ... regulation has a big impact – everyone has a role in it. You need a holistic approach: a framework and a concept. All the different parts need to come together.”

(Swedish academic expert in interview)

This study has reviewed the scientific evidence concerning fatigue in bus, coach and truck drivers, considering the causes of fatigue, measures that can be used to prevent and combat fatigue, and the consequences of fatigue for road safety. It is, moreover, based on an analysis of primary data gathered through a large online survey among bus, coach and truck drivers in Europe, including in-depth interviews and workshops involving drivers, trade union representatives and scientific experts.

Fatigue makes roads dangerous

Our research shows that the prevalence of driver fatigue, typically manifested in the feeling of tiredness while driving, as well as the incidence of actually falling asleep at the wheel, is widespread and a particular problem for bus, coach and truck drivers in all of Europe.

The complex and multifaceted nature of driver fatigue has not been sufficiently taken into account in combating its causes and preventing it

from occurring. Fatigue is a recognised risk factor for accidents. Symptoms of fatigue are cognitive and motor impairments that lead to poor steering control and increased reaction times, as well as other effects. While driver fatigue is seen by many as one of the biggest safety issues facing road transport, the extent of fatigue-related accidents is underreported. Our study, however, underlines the fact that fatigue has other critical consequences, including near-misses and negative effects on drivers' health and well-being. These factors have been largely excluded from previous research.

Not an individual problem

While there is a wide variety of possible underlying reasons for driver fatigue, existing studies mainly focus on a handful of causes, neglecting other important causal factors. The causes of fatigue most often cited in studies are lack of sleep, poor quality sleep and specific sleep demands. However, fatigue also occurs as a result of engaging either in simple tasks for long durations, or in highly complex tasks for a short durations. Both cognitive underload and cognitive overload can generate fatigue. A task-related source of driver fatigue that is often mentioned as playing a role for professional drivers is the lack of stimulation while driving. While these often-cited factors have a real and important influence on the incidence of fatigue, our study discloses various other relevant sources of fatigue, many of them grounded in drivers' working and employment conditions, and in the economic and competitive nature

of both the passenger and freight branches of the road transport sector. Interestingly, very few other studies have analysed fatigue among drivers of buses, coaches and trucks in the context of the specific work environment, the working conditions or the economic framework conditions of the sector. As our research shows, drivers' employment and working conditions are harsh.

Our research identified long working hours in the sector as a key factor contributing to fatigue. Our data analysis shows that, the longer the working hours, the more drivers are affected by fatigue. Among the main reasons for long working hours are the low pay of bus, coach and truck drivers, and the scope the regulations allow to operators for reducing drivers' rest time to nine hours. In addition, fatigue can often directly be associated with the time spent on a certain task. Long periods spent driving have also been associated with an increased risk of road accidents. For bus and coach drivers, both the constant contact with passengers and the increased noise level the passengers generate in the vehicle are sources of stress contributing to driver fatigue.

Long working hours and long stretches of work without days off result in drivers obtaining fewer hours of sleep than they need. A recurring shortage of sleep also increases the risk of fatigue. Sleep loss and cumulative sleep deprivation as well as hours of continuous wakefulness are also identified as risk factors for accidents. Sleep disruption and a poor quality of sleep are further problems. As this study has pointed out, these issues can be the result of interrupted rest time (as, for example in the case of "ferry and train derogation"), sleep apnoea, excessive noise, and drivers' anxiety about their own safety while resting, among other factors.

Better working schedules

The "time-of-day effect" is a main contributor to fatigue for bus, coach and truck drivers. Feelings of fatigue can be linked to the body's circadian rhythm. Irregular working schedules, rotating shifts and frequent changes in the work-rest

schedule, round-the-clock schedules and night work all conflict with circadian rhythms and lead to irregular sleep patterns. This effect is also reflected in varying accidents rates according to the time of the day. Other problems include unpredictable work schedules and short notice of shifts that leave no space for planning.

Work pressure from employers or clients is also given as an important factor contributing to fatigue. Tight schedules and scheduling demands restrict the possibilities for drivers to react to fatigue, and often have a negative influence on breaks and rest time. Our research shows that a large share of drivers – especially bus and coach drivers – who, because of fatigue, have wanted to make an unplanned stop to take a break, have actually not been able to do so. Unplanned breaks are hardly possible when there are passengers on board. Moreover, breaks are often not taken properly. This is partly due to work-tasks having to be performed during breaks; but the pressure to be on time also plays a major role in causing breaks to be shortened or not taken at all. In road freight transport, where schedules are often very tight, truck drivers must frequently meet a set time for a "just-in-time delivery" – instead of being permitted a broader time window.

Too little has been done

Despite the gravity and the widespread occurrence of the problem of driver fatigue and its effects on road safety, attempts and initiatives to tackle the problem have been fragmentary. The complexity of the phenomenon makes prevention a multifaceted venture. As we have shown, various risk factors lead to fatigue, and consequently a series of players must be involved in combating it. Measures to prevent and remedy driver fatigue in the road transport sector can be directed variously at drivers, transport companies, legislation and enforcement, road infrastructure and the design of vehicles. Often however, the only recommended countermeasures have been those intended for professional drivers to implement, and these have usually been self-administered measures, of which the most effective in eliminating fatigue is rest that

includes sleep. However, as our study shows, bus, coach and truck drivers are commonly unable to take sufficient breaks and rest periods. To find effective solutions, the real underlying causes of fatigue must first be identified. Specific causes require specific prevention strategies and countermeasures.

Countermeasures do not lead to a solution if they do not target the causes, or are beyond the capabilities of the actors – in this case the drivers themselves. Identifying the real reasons for driver fatigue must therefore be the first priority. As our study shows, prominent factors that prevent drivers from taking breaks or rests include increasing workloads due to scheduling demands, pressure from employees or clients, long and irregular working hours. In the case of bus and coach drivers, having passengers on board means drivers have little freedom to make decisions, for example, on taking additional breaks.

Our study also shows that many other risk factors are embedded in the working conditions. This conclusion is especially striking in view of the positive selection in our survey in respect of respondents' trade union membership and coverage by collective bargaining agreements; this means that our research samples and reflects better-than-average working conditions in the sector.

Working conditions are key

Consequently, the working conditions of bus, coach and truck drivers must be seen as a major starting point for fighting driver fatigue. However, drivers themselves can do little about the work environment in road passenger and freight transport, and are therefore hardly able to control most fatigue-causing factors. Their working conditions are primarily the result of economic forces. The road transport sector is characterised by deregulation and increasing competition. The demand for inexpensive, flexible, fast and on-time transport has set the parameters in this market, and has seriously harmed the employment and working conditions of drivers. Real control over the fundamental causes of driver fatigue, which are embedded in the working conditions, therefore lies with other actors at the company,

regulatory and political levels. However, even though driver fatigue is a well-known problem in the road transport sector, these actors have not yet adequately developed and implemented strategies for eliminating driver fatigue.

Employers' have responsibilities

Our research has identified manifold countermeasures for employers to take against driver fatigue. These include company-wide Fatigue Risk Management strategies that are implemented from the level of senior management downwards, to prevent and combat fatigue. Such strategies should ensure the provision of better equipment for vehicles (for example, proper air-conditioning), shift planning well in advance, as well as the reduction of physical labour for drivers, since physically demanding work is one cause of fatigue. Among the most important countermeasures identified are the reduction in the working hours of drivers (with redress for any negative effects on the driver's pay) and the reduction of the number of consecutive days that need to be worked. As our data analysis has shown, the way working time is documented has a bearing on fatigue; in companies where working hours are rigorously documented, drivers are less affected by fatigue. Employers therefore need to ensure that all time spent on work-related tasks is counted as working time and is properly recorded (and paid for) as such. With regard to rest time, increasing the length of rest between shifts and ensuring that breaks are fully used to rest and relax are two measures that will help prevent or reduce driver fatigue, and allow for a full recovery between work periods. A very direct way in which employers can influence driver fatigue is to ensure reasonable work schedules that avoid, or limit, night driving, inadequate daily rests and over-long work shifts. It is also down to employers to achieve regularity in work scheduling – to reduce irregular and unpredictable work by providing a longer period of notice for shifts. Another important countermeasure noted in this study, for employers, is removing the pressure on drivers that arises from excessively tight

schedules, by loosening such schedules and reducing the number of just-in-time deliveries. Full compliance with the working and driving times rules is another important point that our research has identified as a factor in countering fatigue that lies within the responsibility of the employers, and must be taken into account in the way they plan journeys.

Strengthen regulation and enforcement

Legislation has the power to remedy aspects of driver fatigue that originate from deregulation and strong competition in the sector. EU directives and regulations already impose requirements regarding working time, driving hours, breaks and rest periods for bus, coach and truck drivers. However, the existing regulatory framework does not seem to be solving the problem of driver fatigue, or reducing its impact on road safety, effectively enough. Hence the call from drivers participating in our study to tighten up the current rules. As for the “ferry/train derogation”, drivers taking part in our research recommended that it should be scrapped completely.

Another problem with the existing regulatory framework is that the regulations are neither

consistently nor effectively enforced. Besides strengthening regulations, a key countermeasure in fighting fatigue is therefore to strengthen enforcement of the current rules through checks and sanctions. Accountability is generally a problem if there are no checks and sanctions, and if the gains from infringements are greater than the penalties for non-compliance; the transport sector is no exception in this respect. Instead of pushing for even more deregulation, this is where future action to combat driver fatigue in the EU should start.

A new paradigm for road transport

All in all, this study shows that driver fatigue is a growing problem, with key effects on road safety and drivers' health and safety, and that the need to combat it is urgent. Fighting fatigue will require complex solutions and strong political will. It requires the involvement and action of many actors who will need to balance social and economic factors if they are effectively to influence working conditions in the sector, and thus to eliminate drivers' fatigue and to improve road safety. Road safety should not be sacrificed for the commercial objectives of cheap, flexible and fast transportation.



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The survey results enable us to identify factors that are statistically associated with driver fatigue. Mean comparison is a statistical technique to quantify associations between two variables. In the context of this project the research question was, “Which factors are particularly strongly associated with driver fatigue?”

In order to create the variable “driver fatigue”, the respondents to our survey have been divided into two groups: (1) those “affected” by driver fatigue, and (2) those “not affected” by fatigue. The basis for this division is in the responses to the survey question, “How often do you drive while feeling tired?” (see table 5).

Drivers who reported that they quite often or sometimes drive while feeling tired are regarded as being “affected” by driver fatigue, while those who indicated that they only rarely or never

Table 5: Responses to the question, “How often do you drive while feeling tired?”

Frequency	Truck		Bus/coach	
	No.	%	No.	%
Quite often (every fourth drive or more often)	619	28.4	220	32.
Sometimes (every fifth to ninth drive)	697	32.0	223	33.2
Rarely (not more than every tenth drive)	544	25.0	160	23.8
Never	231	10.6	50	7.5
I’m not sure / don’t know	89	4.1	18	2.7
TOTAL	2,180		671	

Source: own survey

drive while feeling tired are grouped as “not affected” (see table 6).

In our analysis, we determined whether or not particular factors were associated with driver fatigue by means of cross tabulation. The analysis considered seven different factors: age, country of residence, working hours, documentation of working hours, coverage by collective bargaining

Table 6: Affected and not affected by driver fatigue: grouping based on responses to the question, “How often do you drive while feeling tired?”

Frequency	Affected or not.
Quite often (every fourth drive or more often)	Affected
Sometimes (every fifth to ninth drive)	
Rarely (not more than every tenth drive)	Not affected
Never	

Table 7: Country clusters (relating to the variable “country of residence”)

Central-East	Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia
Central-West	Austria, Belgium, France, Germany, Luxembourg, the Netherlands
North	Denmark, Finland, Norway, Sweden
South	Italy, Portugal, Spain
West	Ireland, United Kingdom
Other	Cyprus, Malta, other

agreements, whether the driving involved international or national transport, and whether the driver was resident in the EU13 or EU15 Member States. With regard to the country of residence, the countries were grouped into six clusters in accordance with the Varieties of Capitalism approach, which groups countries on the basis of having similar industrial relations systems (see table 7).

We found no significant correlation between driver fatigue and the factors relating to collective agreements, international or national transport, and residence in either the EU13 or EU15 Member States. The factors that were found to

have significant correlations with whether or not drivers felt affected by fatigue were those relating to age, country clusters, working hours, and the documentation of working hours.

We carried out a further data analysis using the responses to the questions on “falling asleep while driving” and “having to stop the vehicle, unplanned, due to fatigue” as dependent variables. Since all three analyses produced similar results, the focus of this report is on the results of our data analysis of responses to the question, “How often do you drive while feeling tired?” (see Table 5 above). This question had the highest response rate.



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