
Summary:

Transport operator fatigue in Norway: literature and expert opinion

TOI Report 1395/2015

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Oslo 2015, 129 pages English language

An assessment of existing knowledge is needed to help determine whether more needs to be done to tackle fatigue in professional operators of different transport forms in Norway. Data on Norwegian accidents and incidents confirms that fatigue is an important safety risk in the road, rail and maritime sectors. Despite this, we lack quantitative data on the prevalence of fatigue in Norwegian operators. The causes of operator fatigue in Norway are rooted in framework, organisational and working conditions, as well as individual characteristics and life outside of work. Within the road, rail and maritime sectors in Norway, branches can be identified in which operators are likely to have an elevated risk of fatigue. There is little evidence of systematic programs for the management of fatigue in Norwegian transport, and no evidence that transport companies in any sector actually attempt to measure operator fatigue. However, the rail sector may capture and manage many of the more serious fatigue problems faced by its operators. Widespread fatigue management across all Norwegian transport sectors may first require that the business benefits of tackling fatigue are identified and promoted. Several countermeasures are recommended for use in the road, rail and maritime sectors in Norway.

This report charts existing knowledge on fatigue in professional operators of different transport forms in Norway. In particular, it focuses on the prevalence, causes, consequences, regulation and management of fatigue in the following: professional drivers working in road transport, locomotive engineers (train drivers), and watchkeepers at sea. Knowledge is assembled using literature review and interviews with subject matter experts. The aim of the report is to help inform Norwegian authorities and organisations about the need to manage and tackle transport operator fatigue, and to make recommendations about what could be done. This aim is also to inform a quantitative survey of fatigue in different transport operators in Norway, which will be covered by a subsequent report. The current report is the third in a series of reports produced by the project Fatigue in Transport (www.toi.no/fit).

Increasing time-related demands for Norwegian workers

While general working conditions in Norway are favourable relative to many other countries, a recent report shows that time-related job demands, exhaustion, and stressful work have increased in recent years (Bergene et al., 2014). Increasing shares of people work on the weekends, in the evenings or at night. Long working days (over ten hours) are also on the increase. More varied and demanding working time is ultimately the result of increased market liberalisation, but it is assisted by the flexibility afforded by local tariff agreements, negotiated by representatives of companies and workers. In some transport branches, workers are poorly organised such that their interests may not have been fully accounted for in negotiations on

working time. Thus, despite high social standards in Norway, working time arrangements in transport and other branches may be leading to increased exertion and fatigue.

To assess the extent of any fatigue problem in transport operators in Norway, it would be useful to compare their scores on standard measures of fatigue with norms for the general working population. In the general population, other studies show that a little over 20 per cent of people score positively on two standard scales for general fatigue, and 18 per cent are found to have excessive daytime sleepiness.

Gathering current knowledge on operator fatigue

To assess existing knowledge on fatigue in transport operators, we retrieved and reviewed relevant publications on professional transport operations in road, rail and maritime sectors in Norway. We then supplemented this knowledge with findings from a round of 19 interviews with 26 subject matter experts, selected for their insight into (and experience of) fatigue in the main transport operator roles. We then arranged the information from the literature review and interviews according to whether it concerned the prevalence, causes, consequences, or management of fatigue in transport operators working in Norway today.

Prevalence of operator fatigue

We found no studies enabling us to compare fatigue scores for transport operators with those of population norms. However, according to one study 13 per cent of a sample of professional bus and truck drivers report experiencing at least one episode of sleep behind the wheel in the preceding year. Other non-standard measures also suggest that substantial shares of bus and truck drivers in Norway experience other types of fatigue at problematic levels.

There is very little research on train driver fatigue in Norway. While studies in other Nordic countries show that considerable shares of train drivers report experiencing severe sleepiness and acute and chronic fatigue, differences in organization of the rail networks makes us reluctant to generalize these findings to Norway. Research on the prevalence of fatigue in watchkeepers operating in Norwegian waters is also limited. A Norwegian study of seafarer fatigue in coastal freighter crews finds much higher levels of self-reported safety-critical fatigue for foreign than for Norwegian crew members, but the reasons for the differences are not clear. In a separate study of supply vessel crew, about half of those responding to a survey agreed that they felt completely worn out after four weeks at sea. It is hard to draw conclusions from such findings in the absence of normative samples.

According to the experts we interviewed, stress, physical demands and/or lack of sleep can lead to fatigue in most types of professional operator, whether they are carrying out local or long-distance transport of goods or passengers. However, experts identified operators in certain Norwegian transport branches as potentially having elevated fatigue risks. These were drivers working in coach, goods and taxi transport (road sector); drivers working for smaller rail cargo companies; and watchkeepers working on smaller coastal freight transporters and fishing vessels.

While experts from the rail sector did not think severe fatigue was as prevalent among train drivers as for other types of transport operators, they conceded overall that there might still be important areas to address. Most maritime experts thought fatigue and sleepiness was common at sea. Mental exhaustion may be more prevalent

on busy vessels with many port calls operated around the clock, while sleepiness may be more prevalent on well-equipped, larger vessels on long voyages. Fatigue levels are expected to vary a lot, depending on the nature of the voyage, vessel and with the particular phase of the ship's operation.

Causes of fatigue in the different sectors

We identified several possible causes of fatigue in transport operators working in Norway, and the report details these for operators working in each of the main transport sectors. Each sector and branch is a complex system with unique conditions, which will influence the level of exertion required over time by the individual operator, as well as the opportunity to recover from that exertion, through sleep and rest.

In the road transport sector, authorities maintain and enforce national and EU regulations on working, resting and operating hours, in order to help provide rest periods and patterns that allow for *minimum* sufficient recuperation. However, some drivers in the heavy goods, coach and taxi branches in Norway may struggle to get the job done within the confines of working or driving hours regulations, which in some cases may be used as operational norms rather than absolute limits. Ongoing tension between the demands of the job and regulatory limits must be dealt with largely by the driver, a situation that is not helped by a relative lack of driver representation in these branches. The power of the transport buyer in setting delivery terms and conditions in goods transport branches also contributes to increased strain on drivers. Furthermore, while working and driving time regulations provide important boundaries and do a lot to limit fatigue, they do not account for all causes of fatigue (e.g. they fail to distinguish between night and day driving). The tension between framework conditions and the regulations on working and resting time, together with the inability of regulations to account for the wider aspects of fatigue or hold all transport chain actors accountable for driver safety, may mean that many drivers in these branches often do not get sufficient sleep or rest.

Empirical evidence also suggests that professional drivers in all road transport branches may face poor physical and psychosocial working conditions relative to many other occupations, with widely fluctuating periods of workload, in which they often have little control and lack social support. Experts suggest, however, that the extent to which working conditions result in fatigue depends on road transport branch, organisational conditions, and various individual differences and habits. In Norway, winter driving and a relative lack of resting places may contribute to increase fatigue.

While empirical evidence is scarce, the comments of experts from the rail sector suggest that working time (shift schedule) is also a cause of fatigue for train drivers, albeit to a lesser extent than for operators in road or sea transport. Some of the reasons for this are that train drivers work less hours overall, participate in schedule design, and are obliged and encouraged to report when they become fatigued. It is not clear, however, whether the measures taken prevent the build-up of chronic fatigue, or whether overtime and shift swapping by drivers means that actual schedules worked are in some cases considerably more fatiguing than those planned.

In the maritime sector, empirical evidence is again limited, and focuses largely on coastal freight and supply shipping. Findings suggest that the watch system, watch-timings, manning levels, weather, operational characteristics and length of the voyage

combine to influence fatigue. In many cases there will be curtailed opportunity for sleep, such that sleep timings, sleeping conditions and length of the voyage will combine to determine ultimate fatigue levels. There can be large fluctuations in operational demands over the course of a voyage on some vessels, and in more demanding spells some watchkeepers may struggle to get their work done within regulatory limits.

The 6/6 watch system, commonly worked in Norwegian waters, has been shown by international studies to produce curtailed and poor sleep, relative to other systems. However, there may be operative reasons why schedules that are better at limiting fatigue are not opted for, and in some cases watchkeepers may prefer to work 6/6. Again, fatigue-related challenges faced by an operator depend on the branch in which they work. As in the road sector, operational margins and supply chain actors can also influence working conditions.

Possible causes of fatigue that were common to operators working in road, rail and maritime sectors were working and resting time (including occasional discrepancies between planned and actual schedules worked); branch conditions; organisational culture; psychosocial work conditions; sleeping conditions; commuting; non-work life of the operator; operator's life phase; other individual differences, and Norwegian conditions.

Consequences of fatigue

Norwegian research shows that fatigue contributed to the following:

- Seven out of 44 serious road accidents triggered by professional bus and truck drivers between 2005 and 2008.
- 13 per cent of signal pass incidents by train drivers between 2010 and 2012.
- One in ten groundings in Norwegian waters occurring between 2010 and 2013.

This is just some of the evidence that fatigue is a safety problem in land and sea-based transport in Norway. Most expert comments supported this, and also suggest that these figures may underestimate the role of fatigue in incidents and accidents.

Regulation and management

The main way authorities control driver fatigue in the road transport sector is by legislation limiting working and driving hours. However, data suggest that 31 per cent of professional drives in the Norwegian road sector violate the daily rest rule. Over one in four of these violations is serious and reportable. Such data also suggest a discord between demands/logistics of the job and regulatory requirements for many drivers, some of whom may perceive rightly or wrongly that the regulations themselves contribute to stress, time pressure and fatigue.

Comments from our experts supported the need for the existing legislation limiting working and driving hours in road transport, but they too listed a number of problems. These included inflexibility, incoherence, low risk of detection, and failure to hold all transport chain actors accountable. Experts seemed to think that road transport organisations overall could do more to manage and regulate fatigue among their drivers (e.g. sensible shifts, open reporting culture, well-planned operations, health services who understand driver challenges). Some established companies in certain branches do take steps to tackle the problem (e.g. hazardous goods transporters, ISO-39001-certified companies), but in many goods or passenger

transport branches the organisations are often small, such that business owners perceive that there is too little resource to tackle fatigue.

The regulations on working time at sea are less stringent than in land transport, but these too may be perceived as rigid by seafarers, who may simply want to help their colleagues meet the widely varying demands of a vessel's operation. Captains too may perceive some regulations as failing to address the practical realities of modern shipping, with its low manning and increased demands. As a result there can be large discrepancies between recorded and actual hours worked on board, such that transgressions in the maritime sector may be more systematic and serious than in the road sector. We found little evidence of the systematic management of fatigue by shipping companies.

Working time in the rail sector would seem to be more favorable than in either the road or maritime sectors. Furthermore, compliance of working and resting hours also appears to be better. Conditions encouraging the better management and regulation of fatigue include open reporting culture concerning fatigue; highly organized working relations; participative schedule design; and flexible working time. There may be monitoring by the employer of schedules worked for any fatigue-related problems arising, and importance of driver restitution is appreciated by different stakeholders in the transport operation. There are regular health checks and follow-ups by the company health service. Recent regulations require companies to conduct psychological checks following incidents.

While we could find no comprehensive programs devoted to the assessment and management of fatigue, we found several ways in which rail organisations detect and manage fatigue-related issues, including education of new drivers about the risks of shift working, assessment of shift schedules for fatigue risks, and provision of rest facilities at base.

What can authorities and organisations do to reduce fatigue?

We identified areas that each sector could address to improve the management of fatigue risks. Companies could do more to account for life outside work as a cause of fatigue at work, and to assess either actual sleep obtained or the extent to which operators recover from previous work. There is little evidence of systematic analysis of schedules for fatigue risks in the road or maritime sectors. In none of the sectors do companies monitor on-the-job fatigue, or use formal systems to monitor aspects of behaviour or performance that could indicate developing fatigue. In the road and maritime sectors, many companies could do more to legitimize and support the open reporting of severe fatigue. Learning from investigations of accidents and incidents could also be improved.

To address these and other issues, the report structures expert recommendations on tackling fatigue using an expanded version of the fatigue-risk trajectory (Dawson and Fletcher, 2001). The trajectory describes five levels of fatigue risk that organisations or authorities should address in order to tackle fatigue effectively. The results are shown in Table S1.

Table S1. Recommendations on how to improve transport operator fatigue, structured using the expanded version of the fatigue-risk trajectory of Dawson & Fletcher (2001).

Risk level	Description	Recommendation
-	Set preconditions for risk management	<ul style="list-style-type: none"> Establish business case for tackling fatigue.
1	Working time, work quality, non-work life quality	<ul style="list-style-type: none"> Address any mismatch between hours of work and rest regulations and demands of working. Systematically assess planned and actual work schedules for fatigue risks.
2	Recovery from work	<ul style="list-style-type: none"> Provide facilities and information to help drivers rest, exercise and eat healthily. Consider assessing need for recovery, recovery + fitness-for-duty tests. Empower leaders to help subordinates tackle fatigue. Include fatigue monitoring and reduction as part of company health program. Promote a home life that allows for optimal recovery from work. Address commuting risks.
3	Reports of fatigue and behavioural symptoms	<ul style="list-style-type: none"> Use standard battery to measure and monitor different forms of operator fatigue at work. Monitor links between working time and operator fatigue in order to improve schedules. Legitimise and encourage open reporting of and discussion about fatigue. Give explicit information about what to do in the event of severe fatigue, including how work tasks should be prioritised in the event of fatigue. Legitimise informal ways in which operators cope with fatigue that are likely to be effective. Give operators feedback on personal fatigue tendencies.
4	Fatigue-related errors	<ul style="list-style-type: none"> Improve operator and leader knowledge about how to identify fatigue and associated risks in self and colleagues. Give operators feedback on fatigue-related operational risks.
5	Fatigue-related incidents/accidents	<ul style="list-style-type: none"> Standardise reporting on fatigue as part of incident and accident reporting, whether or not investigators believe it is contributory.

Conclusions

We have charted existing knowledge on the prevalence, causes, consequences, regulation and management of fatigue in human operators working in the road, rail and maritime sectors. We need this knowledge to help decide whether more should be done to tackle fatigue in Norwegian transport.

We found a severe lack of quantitative data on the prevalence of operator fatigue. However, qualitative evidence based on expert interviews suggests that operators in certain Norwegian transport branches may have elevated risks of fatigue, and may therefore particularly merit further investigation. These are, in the road sector, coach, truck and taxi branches; in the rail sector: smaller cargo enterprises; and in the maritime sector: smaller coastal freighters and fishing vessels. Use of standard measurement batteries to assess fatigue would provide data to support these assertions. The need to assess fatigue prevalence rates in operators is underlined by data on Norwegian accidents and incidents showing that fatigue is an important safety risk in each of the road, rail and maritime sectors.

While limited by lack of explicit links to actual fatigue levels, empirical and anecdotal evidence from Norway suggests multiple causes of transport operator fatigue, many

of which may interact dynamically. Contributors to fatigue that span the main sectors each contribute to fatigue by influencing sleep or exertion.

Regulation of fatigue by delimiting operating or other working hours is problematic in the road and maritime sectors, partly because certain operators in some branches may at times need to violate the rules in order to get their work done. In the road sector, there is also lack of coherence between regulations, framework conditions and road infrastructure.

We found little evidence of any organisational programs for the management of fatigue in any of the three transport sectors. Even though the major rail companies address fatigue in several different ways, companies do not formally monitor how tired drivers actually are. Organisations in many road and maritime branches, in particular, could do more to address operator fatigue, but may lack resources due to narrow operational margins.

Identifying and promoting the business benefits of tackling fatigue may encourage the implementation of recommended countermeasures, many of which span the road, rail and maritime sectors. Recommended countermeasures resulting from the findings in this report include:

- Measure and monitor different forms of operator fatigue.
- Carry out fitness-for-duty tests.
- Assess links between working time and fatigue.
- Increase open and systematic reporting of fatigue.
- Educate leaders to help subordinates tackle fatigue.
- Feedback to operators on fatigue-related operational risks.
- Fatigue monitoring and reduction as part of company health program.
- Facilities and information to help drivers rest, exercise and eat healthily.

Companies could also promote a home life that allows for optimal recovery from work, and consider addressing risks from fatigue while commuting.