FATIGUE MANAGEMENT – LESSONS FROM INTERNATIONAL LEGISLATION AND PRACTICE

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ABSTRACT

Fatigue is one of the most commonly experienced problems amongst long distance drivers and results in significant, but unrecorded, number of crashes each year. The methodological difficulties associated with diagnosing fatigue have led to a gap in legislation and traffic management practice where fatigue is regarded largely as un-prosecutable. In fact, in many countries including South Africa, fatigue is not fully defined as an offence under traffic legislation, and hence remains a form of driver behaviour that cannot be effectively targeted. There is a move internationally to address fatigue in traffic legislation and to develop new ways of operationalizing it as a traffic offence. Legislation and traffic management practices in Europe and the US particularly are giving effect to a more aggressive approach in which fatigue is treated actively as a prosecutable offence. While it is still too early to tell if this is having a positive effect of crash rates, the reduction in the number of fatigued drivers is seen as a positive step towards the achievement of safer roads. This paper presents some of the international developments in fatigue – specifically in legislation and methods of fatigue detection - that may have value to road safety practitioners in the South African context.

1. INTRODUCTION

Driving is a complex task that requires constant attention and a high level of focus. Fatigue greatly reduces the ability to drive safely and efficiently (Schmidt et al, 2009). In fact, fatigue is one of the main causes of accidents worldwide. In the UK, fatigue causes around 20% of accidents and in North America the rate is about 40% (Fletcher et al. 2005). In spite of the magnitude of the problem, driver fatigue is scarcely mentioned in many road safety policies across the world. Limited countermeasures are in use and the effectiveness of these methods is still largely unknown.

There are two main problems with fatigue. The first is that there is no internationally recognized or accepted definition of fatigue. Fatigue is a concept far broader than sleepiness – at essence it is about performance and the competence of a driver to respond appropriately to the demands of the drive. Performance itself is a function of physiological impairment (Cercarelli & Ryan 1996) and psychological state (Draganich & Erdal, 2014). While this may sound straightforward, neither of these

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dimensions is simple to identify, categorise or measure (Phillips, 2014). This links to the second problem with fatigue, which is that the physical manifestations of fatigue (generally identified as sleepiness) are difficult to detect without the use of invasive, high-tech and resource-intensive measures such as electroencephalography (EEG) or pupillomerty (Phillips, 2014). Given this, it is unlikely that fatigue, as an element of fitness to drive will easily be operationalised. One legal proxy currently utilized for fatigue is number of hours driven. This is finding its way into some legislation across the world. However, it is difficult for traffic enforcement officials to enforce the number of hours a driver has been driving and often impossible to use it as a basis for prosecution (van der Vijver, 2015). 'Maggie's Law' (New Jersey, US) was the first piece of legislation to be passed to allow the prosecution of fatigued drivers involved in crashes (Radun et al. 2013). Under this law, a sleep-deprived driver can be certified as 'reckless' and can subsequently be convicted of vehicular homicide (Levine, 2005). The legislation was based on scientific evidence that sleep deprivation has direct and measurable effects of a driver's competence (Arnedt et al, 2001). This research, supported later by Rupp et al, (2007) demonstrated that being awake for 18 hours produces impairment equivalent to a blood alcohol concentration (BAC) of 0.05%. At 24 hours, the equivalence is around 0.1%.

The relationship between hours awake and safety performance is not as simple, however, as it may seem. The research by Arnedt et al and Rupp et al aside, the relationship between fatigue and performance is not uniformly linear. Phillips notes: "*Despite increased reports of fatigue in prolonged driving tasks, the effects of safety performance are described as surprisingly weak even after 11 hours of driving… It seems we can maintain some aspects of cognitive performance even when we are fatigued, for instance by increasing exertion, with the result that there is no detectable effect on performance*" (Phillips, 2014:10). Our ability to compensate, in such cases, is not fully understood.

The significance of Maggie's Law was not that it conclusively defined fatigue, but that it was the first of its kind to facilitate the prosecution of a driver as reckless, specifically for driving whilst knowingly fatigued. The fact that only one other state in the US has adopted this legislation is possibly indicative of the difficulties that remain with proving fatigue; i.e. proving the link between lack of sleep and performance impairment. This illustrates the importance of finding a measurable aspect of fatigue to eliminate fatigued drivers from the roads and therefore reduce accidents.

In the meantime, however, given the prevalence of fatigued driving and its consequences in fatal crashes, the option of 'doing nothing' is not acceptable. In South Africa particularly, long distance driving is common, and often involves Heavy Goods Vehicles (HGVs). In 2010, 51.73% of fatal crashes in South Africa occurred during the hours of darkness (RTMC, 2011). Fatigue is clearly playing a key role in our crash statistics, and cannot be ignored. International precedents and experiences are an important base from which we can learn.

2. DEFINING FATIGUE

Various researchers have defined fatigue, however, there is no consensus view and the myriad definitions highlights the multidimensionality of fatigue as a construct. Elements commonly addressed include a subjective sense of fatigue, physiological changes and effects on performance. One useful definition (amongst others) is offered by Shen et al. (2006) who define fatigue as: "*an overwhelming sense of tiredness, lack of energy and a feeling of exhaustion, associated with impaired physical and cognitive functioning*". The definition is useful in conveying a shared understanding of the term but is less useful when it comes to developing a watertight definition for prosecution purposes.

Complex in definition, fatigue is also complex in origin. It has many underlying potential causes. These include sleep deprivation, interrupted or fragmented sleep, circadian factors associated with driving patterns or work schedules, undiagnosed or untreated sleep disorders, the use of sedating medications, and the consumption of alcohol when already tired (Lucidi et al, 2002; May & Baldwin, 2009). The length of time spent on a task (e.g. on a particular journey) and cognitive demands of the task (Thiffault & Bergeron 2003) have been cited as factors. Generally, the two main aspects of fatigue that we consider are sleep deprivation, and sustained task performance (Phillips, 2014).

3. INFLUENCES OF FATIGUE ON DRIVER PERFORMANCE

Sleep deprivation has been shown to have significant impact on cognitive functions of the brain including alertness, perceptual skills, reaction times, psychomotor coordination, judgements, decision making and risk propensity (Curcio et al, 2001; Lim & Dinges, 2010). Sustained task performance brings additional problems, specifically performance decrements (Krueger, 1989). Essentially, the longer a task is performed, the worse it is carried out, a fact that has been confirmed in both laboratory studies and also among drivers in real driving conditions (for example, Sandberg et al. studied drivers in Sweden and showed a clear time-on-task effect.)

Fatigue, be in the result of lack of sleep, or sustained time driving, or a combination of the two, has potential to affect every aspect of a driver's performance. Fatigued drivers are generally unable to fully gauge the extent of their own impairment, which increases the probability of an accident occurring.

4. DIAGNOSING FATIGUE

Fatigue is often designated a contributory factor in crashes only when other factors have been eliminated. In fatal crashes, for example, fatigued drivers are commonly only identified by a lack of evidence of other factors as well as no indication that evasive manoeuvres took place. The underlying reason here is that fatigued drivers lose the ability to respond appropriately to unexpected occurrences (Yang et al., 2009).

Identifying fatigue in drivers *before* an accident occurs is possibly more difficult than attributing fatigue as a factor afterwards. International research has begun to highlight physiological changes associated with fatigue, and engineers are working to develop means of measuring these changes in driving contexts. This is very much work in progress and it is likely that significant breakthroughs in fatigue measurement will be developed in the next decades, building on those that exit already. Fatigue measuring techniques that have been developed for laboratory conditions include:

- Percentage of Eye Closure (PERCLOS): The PERCLOS technique calculates the percentage of time in a minute that eyelids are closed. According to the US Federal Highway Administration (FHWA) and US Highway Traffic Safety Administration (NHTSA), this is regarded as the most promising driver fatigue detecting technique (Singh, Bhatia & Kaur, 2011).
- Ocular Parameters: Measuring the characteristics of eye movement and pupil constriction (Morad et al. 2009).
- Heart Rate Variability (HRV): The use of Heart Rate Variability can serve as an early fatigue indicator. The HRV increases exponentially with increasing fatigue levels (Gershon, Shinar & Ronen, 2009).
- Neurological Parameters: Changes in oscillatory brain activity occur with fatigue, and can be used to identify mental fatigue (Kato, Endo & Kizuka, 2009).
- Head-movements: Head nodding is the last cue before the occurrence of micro-sleeps and the onset of sleep. This measurable aspect is an efficient approach to determine fatigue (Heitmann et al., 2001). Unfortunately, it is the last cue providing an indication that the driver is falling asleep and might have been unfit to drive.

Assessing fatigue in real driving environments is more challenging, given the constraints of time, space, specialist staff and budget limitations. There are numerous devices that have been developed for experimental use but these are not yet commercially available. One such device is the Psychomotor Vigilance Test (PVT), which uses the reaction time of a driver to determine his/her level of alertness. Reaction times are arguably the most important aspect of driver performance when it comes to crash avoidance. They can be measured on palmtop machines with little in the way of supporting computer backup. The PVT has arguably the most potential in the SA context given the simplicity of its use and the relatively low costs associated with the equipment.

A second method, which avoids technology altogether, is a self-assessment test carried out by drivers. Many instruments have been developed over the years to allow drivers to record their experiences – of them the Swedish Occupational Fatigue Index (SOFI) stands out as a sound way of measuring fatigue amongst professional drivers (Phillips, 2014).This technique incorporates multiple dimensions of fatigue, including physical, cognitive and emotional fatigue, grounded in a test that can be customized to the demands to the task – in this case the driving environment.

A third method of assessing fatigue is worthy of mention here. This is the tachograph – a control device that records journey data of a vehicle. This technique, unlike the two mentioned above, does not attempt to measure the impact of the task on the driver, but makes a fairly simplistic assumption that the performance of the driver is directly related to the amount of time spent driving. It disregards any other external factors that could have an influence on the driver. The tachograph presents driving time as a proxy for fatigue. While this is a crude measure, it has the advantage of being consistent and for allowing legislation to be developed which similarly defines fatigue simply in terms of hours spent driving.

5. FATIGUE IN INTERNATIONAL LEGISLATION

The manner in which traffic officials manage fatigued drivers is dependent on whether fatigue is defined in the law, the clarity of definition, and the punishment that is consequently indicated. In this section the main features of fatigue related legislation from the US, Europe and Australia are summarised.

5.1 The United States

Maggie's Law, New Jersey, which was passed in 2003, expanded the state's prior definition of a reckless driver to include fatigue (Levine, 2005:1297). In this case, fatigue is defined simply in terms of time without sleep (defined as having had no sleep for 24 hours). Under this law, a driver who causes a fatal crash due to fatigue can be prosecuted for vehicular homicide. No performance related impairments need to be proven, no physical indicators of fatigue are examined. This is a positive step forward in that fatigue is recognised as being detrimental to driving and a significant contributor towards recklessness on the roads. However, the take-up of the model has been low. Other states within the United States generally believe that there is sufficient provision in their legislation for fatigued drivers to be prosecuted (for example under their definitions of reckless driving and vehicle homicide laws). The fact that fatigued driving in the US does not appear to be declining suggests that the legislation that does exist is not entirely effective.

5.2 European Agreement (AETR)

The European Union has a number of restrictions on driving hours for drivers of goods or public transport vehicles, encapsulated in Articles 6 and 7 of the Regulation of the European Parliament and of the Council No 561/2006. The basics include the following requirements:

- A daily maximum driving time of 9 hours and weekly maximum of 56 hours is mandated. In addition, cumulative driving time over two weeks should not exceed 90 hours.
- Breaks should be taken after 4.5 hours, and should last no less than 45 minutes.

Driving crews crossing international borders are subject to a further Agreement, namely the European Agreement Concerning the Work of Crews of Vehicles Engaged in International Road Transport. The definitions for driving time, breaks and rest periods as stipulated by the Agreement be similar to those defined above, but add an additional stipulation regarding record keeping:

6. This record (of driving) *shall be entered either manually on a record sheet or printout or by use of the manual input facilities of the recording equipment.*
(Regulation (EC) No 561/2006 of AETR Art 6 & 7)

When records or driving time is required by law, a recoding (control) device becomes necessary. Most countries in Europe use tachographs for this purpose. The AETR agreement stipulates the required functionality of the control device as follows:

"General characteristics and functions of control device

The control device must be able to record the following:
Distance travelled by the vehicle;
Speed of the vehicle;
Driving time;
Other periods of work or of availability;
Breaks from work and daily rest periods;
For vehicles used by two drivers the control device must be capable of recording simultaneously but distinctly and on two separate sheets details of the periods listed under 3, 4 and 5." (Regulation (EC) No 561/2006 of AETR Appendix 1)

5.3 United Kingdom

In the United Kingdom (which also falls under the EU), the primary fatigue management approach is similarly to require Passenger Carrying and Goods Vehicles to have a control device installed. The relevant extract from UK legislation is Extract V - Part II Art 97 **Installation and operation of recording equipment in vehicles**, which reads as follows:

"Subject to the provisions of this section, no driver shall drive a vehicle to which this Part of this Act applies unless-
There is installed in the vehicle in the prescribed place and manner equipment for recording information as to the use of the vehicle, being equipment of such type or design as may be prescribed or approved by the Minister for the purposes of this section ; and
That equipment is in working order. (Transport Act 1988 Art 97)

The driver is required to be able to produce a work and rest record for the previous 28 days.

5.4 Australia

Australia is one of the more advanced countries regarding fatigue management for Heavy Goods Vehicles. In February 2014, national legislation changed to facilitate a single regulation for the whole of Australia, namely the National Heavy Vehicle Regulator (NHVR). With this legislation, the responsibility for fatigue management now falls under the national authority and not the regional authority as in the preceding years. NHVR is valid for all vehicles with gross vehicle mass (GVM) over 12 tons and busses over 4.5 tons carrying more than 12 adults.

The NHVR addresses prescribed work and rest schedules, vehicle standards, maximum permissible mass and dimensions and restraining of loads on heavy vehicles.

Fatigue is monitored by officials checking if drivers or employers are adhering to the work and rest requirements as prescribed by the legislation, depending on the type of accreditation of the driver. This is done through a requirement that each driver keep a work diary of previous shifts worked, recorded in a logbook.

A policy of fatigue management is managed nationally through the application of a policy of Advanced Fatigue Management that applies a Risk Classification System (RCS) to drivers based drive/rest profiles of different drivers. This is applied to fleet drivers and Heavy Goods Vehicle drivers only. This system works on identifying high-risk schedules by analysing the combination of work and rest times and allocating countermeasures to mitigate the proposed risk. Each driver is required to evaluate the risk of his/her work and rest schedule by completing a standard RSC matrix.

Drivers and or employers can receive penalties and demerit points for not adhering to the requirements, failing to provide correct documentation or falsifying work and rest records. The police or enforcement officers determine the severity of the offence and the magnitude of fine; however, a maximum value is defined in the NHVR legislation itself. Drivers can receive driver's license demerits points when breaching work and rest schedules requirements.

5.5 South Africa

Although some South Africa traffic departments apply strategies of fatigue management, these are inconsistent, largely undocumented and almost always dependent on the resources available. For example, the Western Cape's Department of Transport deploys an initiative that attempts to reduce fatalities by drivers to rest before continuing on their journey. This is done by engaging with the drivers of public transport or heavy goods vehicles and asking them about their drive/rest schedule.

While many traffic officials are keen to be more proactive and effective in fatigue management the major problem, facing them is the lack of clear legislation making fatigued driving an offence. The closest wording in the South African legislation (Section 31 of the Road Traffic Act) allows a driver to be temporary stopped from driving if a traffic officer deems them unfit to drive ("incapable of driving").

3I *Powers and duties of a traffic officer*
(b) when in uniform, require the driver of any vehicle to stop such vehicle;
…

> *"(f) if a person, being the driver or the person apparently in charge of a motor vehicle, appears, by reason of his or her physical or mental condition,* ***howsoever arising****, to be incapable for the time being of driving or being in charge of that vehicle, temporarily forbid the person to continue to drive or be in charge of that vehicle and make the arrangements for the safe disposal or placing of the vehicle as in his or her opinion may be necessary or desirable in the circumstances;*

If they fail to stop driving on the instructions of a traffic officer, an offence is created under Section 3J as follows:

3J Failure to comply with instruction or direction of inspector of licences, traffic officer, examiner of vehicles or peace officer

(1) No person shall

fail to comply with any instruction or direction given to him or her by an inspector of licences, traffic officer or examiner of vehicles, or obstruct, hinder or interfere with any inspector of licences, traffic officer or examiner of vehicles in the exercise of any power or the performance of any duty in terms of this Act;"

(NRTA 93 of 1996, S3.I & S3.J emphasis added)

A driver can be prosecuted for failing to stop driving temporarily, but may not be prosecuted simply for driving fatigued.

5.6 Summary

The general approach internationally is to prevent fatigue by limiting the contributing factors of fatigue, for example, by limiting the length of time a driver is allowed to drive before taking a break. This convention currently applies only to HGV and public transport drivers, not drivers of private non-commercial vehicles.

Australia is leading in fatigue management of HGVs with an unconventional approach. This approach is based on determining the level of risk of each driver based on an assessment of the drive/rest schedules they have followed. Although there is only one regulation governing fatigue management of heavy vehicles in Australia, there is still a degree of discretion applied which allows officials to use their judgment to determine the severity of the offence committed. Consistency could be further enforced by setting more clear boundaries for what is severe, substantial etc.

A summary of the international applications for HGV drivers is provided in Table 1 below.

Table 1: Overview of International applications

International application	Maximum driving time				Minimum breaks			Rest
	Daily	Exception	Weekly	Two weekly	Drive	Break	Alternative	
	hrs	hrs	hrs	hrs	Hrs	min	Min	min
EU	9	10 twice a week	56	90	4.5	45	15	30
UK	10	-	-	-	5.5	30	-	-
Australia	RSC Matrix				5.5	15	-	-
South Africa	-	-	-	-	-	-	-	-

Source: (Risk Classification System tool, 2014 & Rules on Drivers' Hours and Tachographs: Goods vehicles in GB and Europe, 2011 & Department for Transport, 1968).

No country currently lays down maximum driving times for drivers of private vehicles. Maggie's Law is the first of its kind to begin to address the problem of fatigue among non-HGV drivers by defining fatigue as a function of number of hours since last sleep. However, the problems associated with identifying and legally defining fatigue remain a problem for many countries, including South Africa.

6. FINDINGS FROM SOUTH AFRICAN SURVEYS

Against this background of the international definitions of fatigue, a survey was carried out with South African drivers to assess the average driver's understanding of fatigue, and their experiences of fatigue management. Two surveys were compiled and distributed. The first focused on driver fatigue, the second on perceptions of traffic officials. Both surveys were administered in the Western Cape only. The findings from the two surveys are discussed below.

6.1 Driver fatigue survey

The distribution of the driver fatigue survey by age and gender is demonstrated in Figure 1. This survey had a sample size of 101 and was answered predominantly by males. A good distribution of different age categories was achieved.

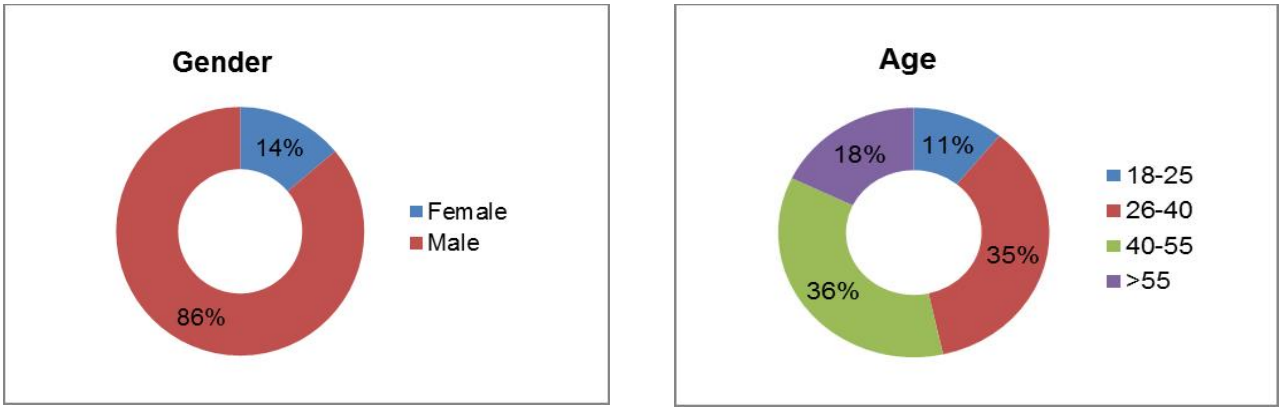

Figure 1: Age and gender distribution of driver fatigue survey

The driver categories were made up of light vehicles, heavy vehicles and minibus taxis (73%, 23% and 4% respectively).

Drivers of all these categories overwhelmingly believed fatigue to be an important issue on South African roads - 96.9% of drivers indicated that driving fatigued is dangerous. However, an important point to consider is that only 62.1% of these drivers believed that they were personally vulnerable to driver fatigue.

This discrepancy can be attributed to various factors including the fact that drivers are in denial about their weaknesses and are unwilling to admit to falling asleep while driving. However, it could also indicate that drivers are not sufficiently well educated on fatigue and its effects.

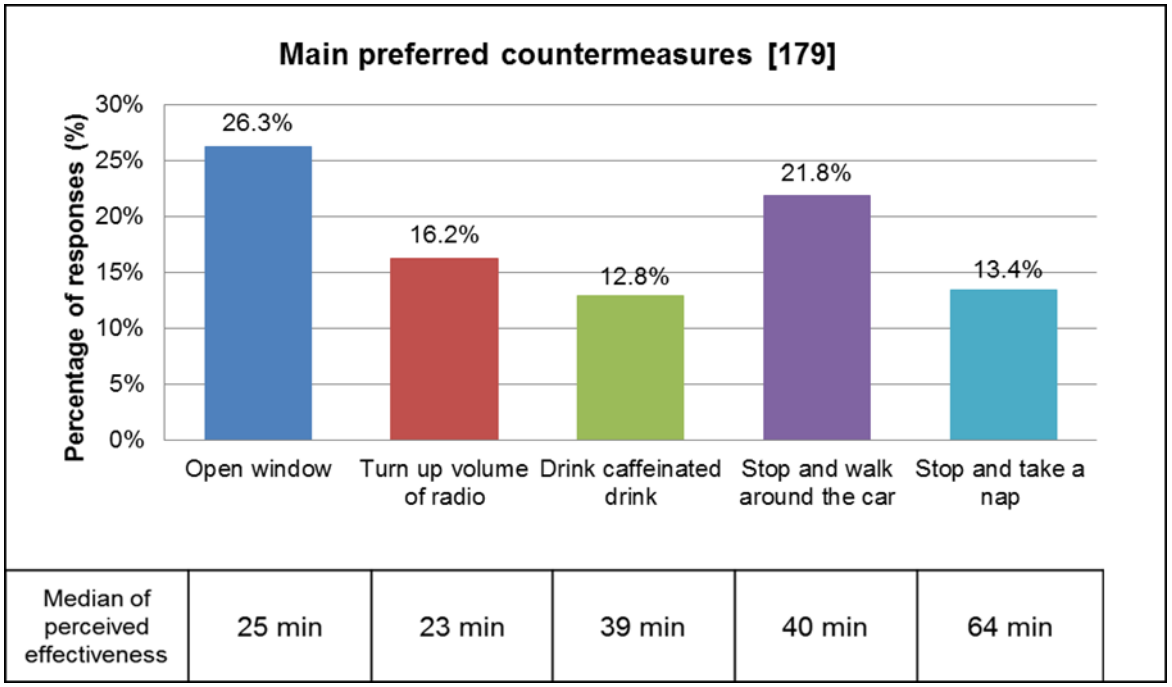

Figure 2: Main preferred countermeasures from drivers

From the driver fatigue survey, it was determined that the most popular countermeasures to fatigue were “to open the window”, “to stop and walk around the car” and “to turn up the volume” (at 26%, 22% and 16% respectively). Unfortunately, “to open the window” and “turn up the volume” have both been proven to have limited effectiveness (Reyner & Horne, 1998). It can be seen in Figure 2 that the countermeasures with the longest indicated effectiveness (‘stop and walk around the car’, and ‘stop and take a nap’) are only used by 13% of drivers.

The majority of the drivers indicated that they are aware that there are certain periods of the day when a driver is more susceptible to fatigue. However, only half of them indicated that they would consider whether they had had enough sleep prior undertaking a long journey.

The majority (77.4%) of drivers indicated that they would stop driving fatigued if it was addressed through legislation. To determine what measures could be established that may potentially stop drivers from driving fatigued, four possibilities were suggested in the survey (see Figure 3). Here, 36.5% of drivers indicated a preference for non-punitive options – in this case to a traffic officer “parking” their car and encouraging them to rest before continuing with their journey.

However, the majority of responses were shared among the more punitive consequences - respondents indicated that the risk of receiving a fine, having their vehicle confiscated, or facing a custodial sentence would each prevent around 21% of drivers from driving fatigued.

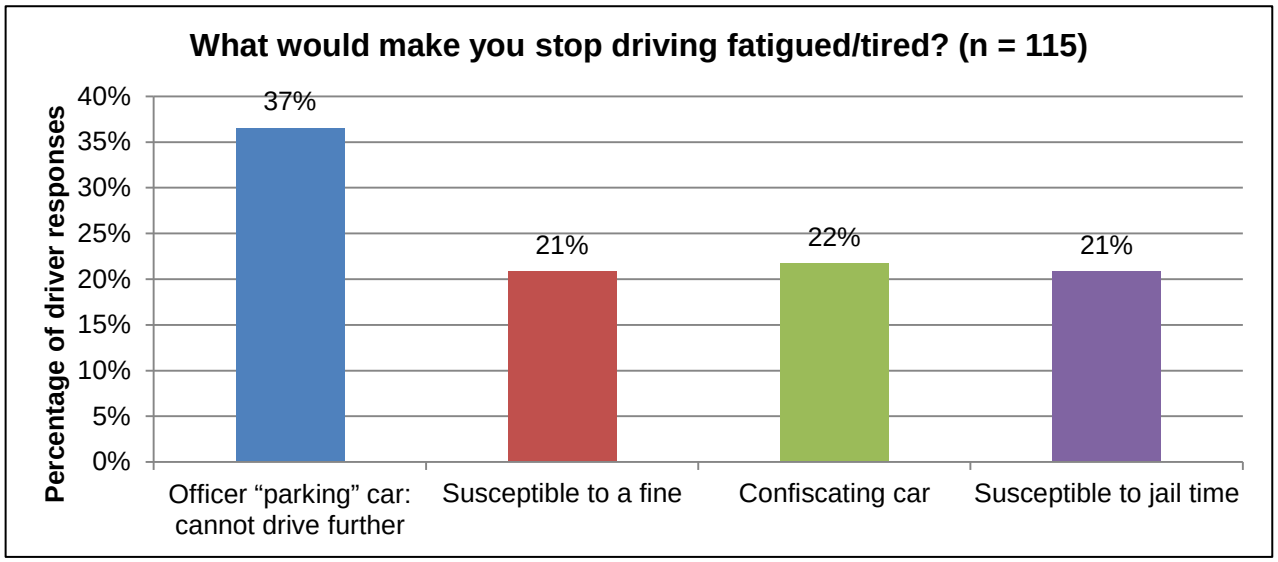

Figure 3: What would prevent drivers from driving fatigued?

These results indicate that drivers acknowledge that legislation would need to include consequences with higher punitive costs in order to be effective.

6.2 Traffic official survey

The traffic official survey was administered at the two traffic centres where Western Cape traffic officials receive training on fatigue management. The focus of their fatigue campaigns is on public transport and Heavy Goods Vehicles (HGV). The age and gender distribution of the traffic official fatigue survey (n = 57) is demonstrated below in Figure 4.

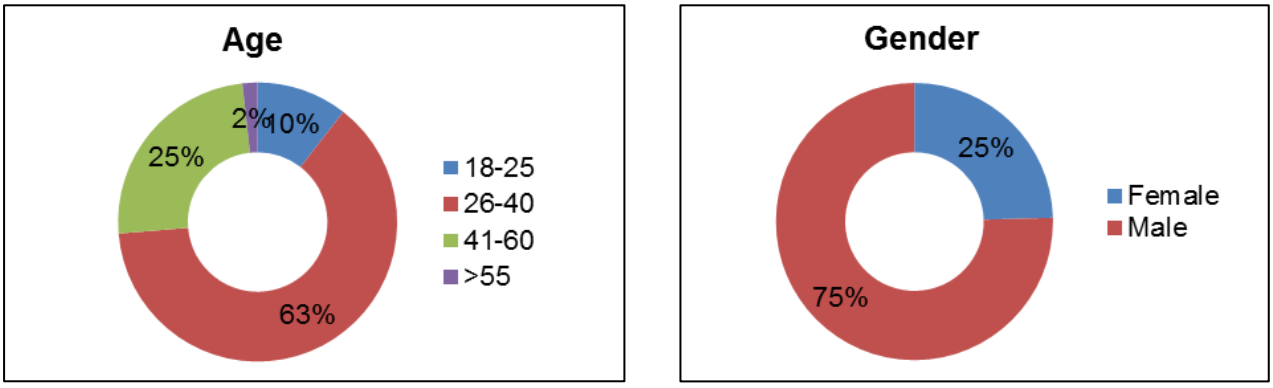

Figure 4: Age and gender distribution of the traffic official survey

The results indicate that traffic officials do not believe that they encounter fatigued drivers on a regular basis. It also, importantly, highlighted the fact that traffic officials have limited knowledge on fatigue identification and management, and thus their perceptions of the incidence of fatigue could well be flawed. In terms of identifying fatigued drivers, 93.5% of the respondents identified yawning, rubbing of eyes and slow eye movements as the indicators to look for. A total of 75.6% of traffic officials indicated that they would find it useful to receive further training on how to identify fatigued drivers.

Traffic officials believed strongly that the public was poorly educated about fatigue and that drivers are determined to reach their destination as quickly as possible. In their experience, drivers will not feel obliged to stop and rest until the legislation specifically addresses the issue and/or an effective system is in place to force them to do so.

The traffic officials also reported an insufficiency of rest facilities provided next to the road for a driver to stop and rest. It was noted that it is fairly common for an officer to encounter a fatigued HGV driver when the resting facilities are full. Because there is no space for the driver to park in a safe space without obstructing the road, a driver will often choose to continue on his journey. This suggests that the rest areas do, in fact, provide an effective solution to HGV driver fatigue, but that more rest areas are needed for the policy to be completely effective.

The traffic officials use two approaches to handle fatigued drivers, namely to (1) give verbal warnings; and (2) encourage drivers to park their car and rest before continuing on their journey. The challenges facing them were lack of legislation (already addressed), cooperation of drivers, difficulty in classifying fatigued drivers and inadequate resting facilities for identified drivers.

6.3 Summary

One of the major difficulties of fatigue management is the lack of a definition or legal restrictions regarding fatigue. Without a benchmark value of fatigue for the traffic official to compare the driver against, the classification of driver fatigue is left to the discretion of the traffic official.

The majority of drivers know that driving fatigued is dangerous, however many believe either they are not vulnerable to fatigue or they actively choose to disregard the warning signs and to keep on driving.

If a minimum standard of the state of the driver with reference to fatigue is addressed in the legislation, it would provide traffic officials with a platform to remove fatigued drivers from South African roads. By evaluating drivers against the stipulated minimum state, it would provide traffic officials with a stronger argument to prosecute drivers.

7. TOWARDS A NEW APPROACH TO FATIGUE MANAGEMENT IN SOUTH AFRICA

One of the major difficulties of fatigue management is quite clearly the lack of a definition or restrictions regarding fatigue. There is no law stating the time limit a driver is allowed to be on the road, or the distance the driver is allowed to cover before a rest is required.

The survey revealed that most traffic officials believe that drivers are poorly educated on safe driving behaviour and on how to avoid or combat fatigue. This was to some extent confirmed in the survey of drivers, the majority of whom indicated that they are not susceptible to fatigue, and who admit to using a range of countermeasures that have little or only short-term effect.

Any fatigue management programme is reliant on the cooperation of the drivers. In South Africa at present, because there is no legislation in place, traffic officials have no power to influence drivers. Traffic officials often have little backup when a driver refuses to rest and they also have no control over how long a driver that has been pulled off rests before continuing on journey.

International experience of fatigue management has some lessons for the South African context. By way of concluding this introductory paper on fatigue, three areas of improvement are proposed.

7.1 Legislative

Possible legislative routes were suggested in the surveys by the traffic officials. The most significant and potentially viable one is to legislate the maximum number of hours that a single driver of a public vehicle or a HGV can drive for without a rest. Such legislation would enable drivers who have been driving in excess of this maximum time to be a) removed from the road, and b) prosecuted. The legislation should also set minimum break times for drivers so that they can be adequately rested when they resume. This ties in directly with the types of legislation that have been developed elsewhere in the world to manage fatigue.

The proposal for a South African solution could be based on international standards. As a suggestion, legislation should apply to drivers of public transport vehicles (any vehicle capable transporting more than 12 individuals) and HGVs (exceeding 3.5 tons).

Proposed maximum allowable work limits are provided in Table 2, with rest and break limits in Table 3.

Table 2: Maximum Allowable Work Limits

Work Limit	Maximum Hours	Exception
Daily	9	Extendable to 10 hours no more than twice a week
Weekly	56	
Two-Weekly	90	

Table 3: Minimum Break Requirements

Driving	Break
4.5 hours	45 continuous minutes
	15 minutes followed by a minimum of a break of 30 continuous minutes

- Each vehicle as mentioned above should be required to have a control device (E.g. tachograph) installed to record journey information, work and rest schedules of the drivers.
- For the intermediate period, drivers should be allowed to use logbooks. This, however, is both the driver and employer's responsibility.
- The installation and maintenance of the control device should be the responsibility of the employer and a record of should be kept by the driver for one month (28 days).

Future legislation could define driving fatigue (by all drivers) as a prosecutable offence. This would be most effective when reliable and effective tests for fatigue are available.

7.2 Traffic enforcement

The powers and duties of the traffic officer can remain as stipulated in the NRTA S3.I as provided in Section 3.6.6. However, the amendment detailed above would provide traffic officials with a measurable method of assessing the degree to which a driver is fatigued, and a basis for prosecution. It is recommended that this section be added to Chapter 5 "Fitness of Drivers" in the NRTR 2000.

All traffic departments in South Africa should be involved in a national campaign to reduce fatigue on South African roads and should all receive the appropriate training to do so efficiently.

Traffic officials and the public drivers should be equally informed about the various elements of fatigue that include causes of fatigue, vulnerable parties, countermeasures to combat fatigue and physical signs of fatigue. Additionally traffic officials should be adequately trained on the procedure to follow with a fatigued driver and how to identify a fatigued driver.

7.3 Education

As indicated by the survey responses, there is a lack of a comprehensive understanding of fatigue by traffic officials and the public. These two role players are both instrumental to reduce fatigue successfully on South African roads and neither can achieve the desired outcomes independently.

A driver cannot combat fatigue if he/she is not properly informed about the potential risks of driving while fatigued. Similarly, a traffic official cannot effectively and efficiently identify a fatigued driver without the appropriate support provided by legislation, and the appropriate knowledge of fatigue indicators.

In addition to sustained enforcement initiatives, national anti-fatigue awareness campaigns should be conducted regularly, both during and outside festive seasons.

7.4 Engineering responses

This paper has not addressed engineering responses to fatigue, which is itself a wide and separate topic. However, the problem of fatigue cannot be dealt with by enforcement and education alone. Traffic engineers are important role-players in this regard and have multiple contributions to make, not least in developing new and effective ways of increasing driver alertness (surface treatments, signage etc.), providing rest areas for fatigues drivers and implementing a policy of forgiving road design. While fatigue can and must be reduced, it is likely never going to be removed completely as a threat.

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