

AN OVERVIEW OF THE FACTORS ASSOCIATED WITH DRIVER DISTRACTION AND INATTENTION WITHIN THE SOUTH AFRICAN RAILWAY INDUSTRY

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Abstract. Driver performance and the attention the driver pays to the primary task of operating trains safely have been shown to decrease because of driver distraction and inattention. The paper presents the factors associated with driver distraction and inattention within the South African railway environment, current interventions utilized by South African railways and the impact these interventions have on driver distraction. The paper also stresses the need to conduct future research into driver distraction in order to mitigate the contribution of driver distraction and inattention to railway occurrences experienced in South Africa.

Keywords: Human Factors Driver Behaviour Train Driver Distraction Inattention South African Railway Industry

1 Introduction

Driver distraction and inattention has been found to be a contributing factor to accidents and plays a role in railway occurrences that have occurred in the South African railway industry.

The factors determined to contribute to driver distraction and inattention range from the technologies introduced to improve driver performance, secondary tasks believed to increase safety and aid in the safe operation of the rolling stock, as well as interventions thought to maintain driver alertness. Examples of some contributory factors include excessive noise from the cab design, the lack of toilets on the trains, the use of the dead man's switch and of mobile phones, listening to music and conversing with a passenger, as well as the use of a train driver assistant. Although the nature and application of the technologies may differ, the collective objective of said technologies introduced is to prevent driver distraction, but often times these interventions further add to the inattention from the primary task of driving trains.

While technology has the potential to improve safety while driving, its acceptability and adequacy should be investigated thoroughly before implementation in the railway industry, taking the driver's needs and functional abilities into account [1].

Despite the complexities associated with driving, it is typical to see drivers executing other activities while driving, such as talking to passengers or listening to music [1] often times without understanding the consequences related to attempting to multitask while driving or understanding the level at which their safety is compromised.

While literature has provided abounding research on the contributing factors to driver distraction, many of the theories on the measurement of driver distraction are conflicting. The findings from studies have also been inconclusive and some of the interventions put forward may not be practical in different contexts or environments.

The majority of the literature available on driver distraction and inattention focuses on road vehicle drivers and a few have been studies conducted in the US, UK, Australian and New Zealand railway industries. Very little to no research has been conducted within the railway environment in South Africa and the effects of the current risk factors and interventions that exist in South Africa have not been adequately researched. Research into the factors affecting driver distraction is critical to prevent accidents and increase the railway safety [2]. Driver distraction can lead to the train driver missing vital information such as signals, approaching trains, road vehicles or pedestrians at level crossings [3].

While the contribution of driver distraction and inattention to South African railway occurrences has yet to be quantified, the need for in-depth investigation into the matter is required in order to provide practical and realistic interventions and is crucial in the pursuit of achieving zero railway occurrences.

1.1 Aims and objectives

The objective of this paper is to highlight the factors associated with driver distraction and inattention within the South African railway environment and to contextualize how the existing interventions introduced in South African railway can affect driver distraction and inattention. This paper also aims to provide a baseline in order for the South African railway industry to continue and further the research in an attempt to quantify and understand how driver distraction and inattention contributes to railway occurrences and how it can be mitigated in order to decrease the number railway occurrences in which driver distraction play a role.

2 Driver distraction and inattention

Different definitions for driver distraction and inattention exist within the literature, with conflicting meanings and interpretations depending on the context in which they are used. Driver distraction is defined by Naweed (2013) as “the diversion of attention away from activities critical for safe driving towards a competing activity”. The National Highway Transportation Safety Administration (NHTSA) has defined distracted driving as “an activity that could divert a person’s attention away from the primary task of driving” [5]. Other literature presented by Freund *et al.* (1995) defines driver distraction as a loss of attention [6]. What the definitions seem to suggest is that distraction diverts the person’s attention away from something and that diversion interrupts the ability to concentrate on something else [7].

The definition that is perhaps relevant for the context of this paper is that of the American Automobile Association Foundation for Traffic Safety, who define driver distraction as occurring “when a driver is delayed in recognizing information that is required to safely complete the driving task due to some event, activity, object or person within or outside the vehicle compelled to induce the driver’s shifting attention away from the driving task” [1].

There are three categories in which distracted driving is classified in Craye and Fahri (2015):

1. Manual distraction, where the driver removes their hands from the steering wheel;
2. Visual distraction, where the driver removes their eyes from the road; and
3. Cognitive distraction, where the driver’s mind is not entirely focused on driving due to talking to other passengers, using cellular phones or merely thinking.

While the above categories are applicable within the railway industry, Young *et al.* (2003) presents a fourth category, auditory distraction. Auditory distraction is stipulated to occur when a driver momentarily or continuously focuses their attention on sounds or auditory signals instead of focusing on the road [1]. Auditory distraction typically occurs when the driver is listening to the radio or holds a conversation with a passenger, but is most pronounced when using their mobile phone [1].

There is a currently a lack of understanding of the different types of driver distraction and inattention and the mechanisms that give to distraction in the South African railway environment. These mechanisms have different implications in terms of the types of interventions used and the likely effectiveness of such interventions [7].

2.1 Factors affecting driver distraction in South African railways

Operating trains requires a high level of concentration, attention and alertness [9]. Train drivers are affected by visual, cognitive, auditory, as well as psychological and physical disturbances [2]. The driver’s predisposition to various disturbances and risks that impact distraction increase the longer the driver must sustain attention [6]. The complex interaction of various factors such as tediousness, physical and mental workload, environmental stressors, the quality and quantity of sleep and circadian effects result in distraction and inattention [6].

Research has demonstrated that loss of attention typically occurs when the driver works for long periods, receives inadequate sleep or works during times when circadian rhythms are at their lowest [6]. Further research on task-related distraction in the rail industry is required in order to fully understand the other contributory factors to distraction and inattention [10].

While many factors exist that distract train drivers, the focus of this paper will be on the use of mobile phones, locomotive design and the physiological and psychological conditions as these factors are the most prevalent within South African railways.

The use of mobile phones. The research on the use of mobile phones is extensive within the road transportation industry; however the contribution of mobile phones to driver distraction in the South African railway industry is somewhat lacking. Studies on driver distraction conducted by the Rail Safety and Standards Board (RSSB) have

found the use of mobile phones to be of particular concern. One particular study conducted by the RSSB found that the use of mobile phones lead to reduced situational awareness, poor speed control, slower reaction, reduced decision-making and less attention paid to checking for hazards [3].

Research has shown that while completing different cognitive tasks, two different areas of the brain are utilized, which can result in performance problems while attempting to perform those tasks [11]. According to Wickens (2008), this could help to explain why using mobile phone can have an effect on what the driver sees as the tasks compete for the brain's information processing resources, which in turn limits mental workload.

The use of mobile phones while driving has been shown to cause physical and cognitive distraction and has also been shown to significantly diminish the visual search patterns employed by the driver, the reaction times, processes used to make decisions and the ability of the driver to maintain speed [1].

In the South African context, the use of mobile phones while operating trains is somewhat of a vexation. The primary means of communication in South African railways is the trunk radio. Most locomotives are fitted with a trunk radio and the driver is required to use the trunk radio when communicating with other railway employees. The problem that arises is that most of the trunk radios have been found through audits and inspections to be consistently defective in most locomotives. This forces the train drivers to utilize their private or company issued mobile phones to communicate with the other employees. The distraction is further compounded by the fact that in certain areas of South Africa, the cellphone reception/signal is poor. The lack of or breakdown in communication has been found to be a contributing factor to many railway incidents, but the contribution of the distraction arising from the use of mobile phones is not absolutely clear.

While some of the South African railways have developed circulars forbidding the use of mobile phones while operating the train in certain conditions, the enforcement thereof is minimal and is difficult to enforce during train journeys. The RSSB has highlighted the difficulties associated with enforcement and recommend an education framework that will ensure that train drivers fully comprehend the potential risks and implications related to the use of mobile phones and key decision-making skills, so that driver are effectively able to assess the conditions in which it is safe to use the mobile phone [3]. The education framework could be of vital benefit to South African railways if utilized in a contextual manner.

Locomotive design. The cab of the locomotive can be a contributing factor in cases where the seating is uncomfortable, where there is excessive noise [9] or where the equipment in locomotives is not functioning (e.g. faulty trunk radios). The above-mentioned contributing factors can be found in most of the older and outdated locomotives used in South African railway companies.

While new and modernized locomotives have been purchased, the older locomotives have still not been phased out and therefore some drivers are still exposed to such conditions. Diesel locomotives are used in various parts of the rail network where there is no overhead power and these locomotives have been found to expose the drivers to higher levels of noise. Compounded with the resistance to wear hearing protection to decrease the exposure to noise and the distraction associated therewith, the distraction provided by excessive noise still remains a significant problem for South African train drivers.

Most of the older locomotives in South Africa do not have toilet facilities, which can add to the driver's distraction as it means that the driver must wait to relieve himself or herself. This is not particularly a problem for train trips of shorter lengths, but poses a greater distraction for longer train journeys.

The use of older locomotives raises a need to investigate the effects of cab design on driver distraction and railway incidents further as the effect of the distraction as a result of the locomotive design has also not been adequately investigated. Therefore, the mitigation of said effects through the procurement and use of new locomotives will be difficult to evaluate.

Physiological and psychological factors. Certain medical or psychological factors can adversely affect the driver's alertness [6]. According to the National Safety Council (2010), research has identified "reaction-time switching costs", which is the time the brain spends switching its attention and focus from one task to another. It has also been discovered that spending even small amounts of time switching from one task to another can lead to adverse risks with regards to delayed reaction and braking time [3].

During driving, the brain must extract information from shared and limited resources in order to fulfil the other tasks, which places constraints on the mental resources available for the primary task [12, 13].

While certain physiological and psychological conditions predispose the train driver to distraction and inattention, no research has been conducted in South African railways to determine the extent of the distraction that arises from these conditions.

2.2 Interventions to mitigate driver distraction

"Train driver tasks are without a doubt psychologically demanding" [9]. In South Africa, the train driver is bombarded with different signals to observe, road vehicles to look out for at level crossings and other operational duties, such as communicating with the train control officer and checking that the load is still intact.

Railway companies employ different interventions in an attempt to mitigate driver distraction and in an attempt to improve operational safety. While introducing new technologies may increase the attention of the driver, the technologies must be investigated and the behavior of the driver must be addressed before implementation in order to determine whether the technologies will have any adverse effects on the driver [14]. Research has demonstrated that some of these interventions have offered little guarantee, while others have been criticized. The use of these technologies differs from country to country and from operator to operator.

Within South Africa, there are a number of strategies used, including the dead-man's switch (vigilance switch) and the driver assistant.

Dead-man's switch. South African railways utilize the dead-man's switch, or vigilance switch, as a means of checking the alertness of the train driver. This switch is a method employed to check the alertness of the driver in that it requires a response from the driver. In most long haul railway industries, the switch is installed on the floor of the cab, in front of the driver's seat. The switch sets off a noise at set intervals and the driver is required to use their foot to press the switch, failing which the device is used to apply the brakes automatically and the train comes to a stop [15].

One of the problems that arises with the use of the dead man's switch is that the drivers hear the noise emitted frequently and press the button without actively thinking about their actions [16]. This becomes automatic and if the driver is distracted or pre-occupied with other tasks, the automatic pressing of the button occurs without thinking about the train speed or location [16].

The implementation of the dead man's switch in South Africa is a bit of a sore point, particularly the positioning of the dead man's switch. The main issue found with the positioning of the switch is that the driver's continue to drive the train with the foot on the switch continuously instead of pressing the switch when required. This defeats the purpose of the switch as drivers continue to be distracted with other activities and factors, thereby nullifying the objective of the switch.

Other positions where the switch can be installed were not explored extensively before implementation in South Africa. The most effective position in which to place the dead man's switch must be investigated, as the switch should provide the required input from the driver while ensuring that the alertness of the driver is maintained and verified as desired.

Driver assistant. The use of a driver assistant is an intervention that is unique to South Africa. The functions of the driver assistant vary from operator to operator but the primary function of the driver assistant is to assist the train driver in the movement of the train. Some auxiliary functions of the driver assistant include assisting the train driver to observe signals, reminding the train driver about speed restrictions, assisting with checking the train load and verifying the information communicated to the driver by the train control officer.

While conversing with passengers may not seem to be a great risk as it is an activity that is considered to be of low risk, Pauzié *et al.* (2007) reported that passengers can be a form of distraction to the drivers under certain situations.

Some investigations into railway occurrences have revealed the driver assistant to be a distraction to the train driver at times, particularly through the conversations held by the driver and driver assistant. Conversations that have resulted in the driver missing vital information, such as signals at danger or speed restriction boards erected; leading to signals passed at danger or derailments due to the non-adherence to speed restrictions.

The employment of a driver assistant to assist the train driver and the effects thereof have not been investigated in South Africa. Future research conducted in South Africa should include an assessment of the driver assistant and the role the driver assistant plays on driver distraction and railways incidents.

3 Future research to determine driver distraction

Within the railway environment, there are currently a number of methods utilized to determine driver distraction. Some of the more common methods employed globally include driver response measures, vision related measures and manual-related measures [2].

Eye-tracking studies. Eye-tracking is a common method used to determine driver drowsiness and alertness. The movement of the eyes typically shows where the driver's

attention is focused. This is the reason why studies have utilized eye glance behavior to determine driver attention [2].

Eye-tracking studies have been conducted in the UK rail industry. One particular study focused on tracking the movement of the driver's eyes while operating a train. The study revealed that drivers spend about 50% of their time scanning the visual scene when approaching signals. The remainder of the time was spent focusing on railway signs, infrastructure and locations next to the track and signals [17].

Eye-tracking studies can help South African railways to determine how much time the driver spends focused on the primary task and can assist in determining how much time other activities and factors contribute to driver distraction.

Questionnaires and other subjective methods. No verified questionnaire has been developed for use in railways yet, but questionnaires do exist for use in the road industries. These questionnaires can be modified so that they are suitable for the railway environment, but it will be important to ensure that they are specific to the environment in which they are being used. The questionnaires also need to consider all the contributing factors to driver distraction and need to effectively quantify the self-reporting and self-assessment of driver distraction.

One of the most used subjective assessment is the NASA TLX. This tool is easily available and can be administered effortlessly for train drivers to determine the workload associated with the primary and secondary tasks. Another tool that has been developed that has not gained the same amount of popularity as the NASA TLX is the Driving Activity Load Index (DALI). The DALI is similar to the NASA TLX as it has a scale rating. The main difference between the two tools is that the DALI is directed towards driving tasks. This tool has been effectively used for the road transportation industry but the application in the railway industry has yet to be investigated [4].

According to Freund *et al*, (1995), some important questions to ask in the investigation of driver distraction and inattention are:

- How to define driver distraction and inattention within the South African context;
- When does it happen and as a result of the contribution or combination of which factors;
- How much does the driver distraction affect the deterioration of operator performance; and
- How can it be mitigated?

No studies have been conducted in South Africa resulting in a void in the information available in this regard. Future research in this field is required in an attempt to quantify the contribution of driver distraction to railway occurrences.

Future research can take from studies conducted in US, UK, Australian and New Zealand railway industries; however, the application must be specific to the South African environment.

4 Discussion/Conclusion

There is extensive literature available regarding driver distraction and inattention in the road transportation industry. The current literature available for the railway industry mainly exists within the US, UK, Australian and New Zealand railway environments.

While this information is crucial to understanding driver distraction and inattention, the application to the South African environment must be investigated as the interventions and technologies utilized could have different consequences. The need for future research into this matter is greatly required in South Africa in order to determine the level at which driver distraction and inattention contributes to South African railway occurrences.

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