Road Safety and the role of the employer: A case study of a western multinational in Oman.

A thesis submitted to Middlesex University in partial fulfilment of the requirements for the degree of PhD.

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Submitted December 2019

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Abstract

Global data highlights the scale of road traffic driving harm showing 1.24 million deaths, and a further 20 to 50 million injuries annually, making it the eight-leading cause of death globally. A range of studies has shed light on the causes of such harm, its main contributing factors and the prevention strategies that can be adopted to reduce it. However, little attention has been paid to the role played by employers in preventing work-related driving harm, despite the fact work-related driving accounts for a significant proportion of the harm flowing from road accidents.

This study represents an attempt to address this lack of research. The overall aim of the study was to shed new light on the role the employer can play in reducing work-related driving harm. Three supporting objectives were developed to support this aim. The first was to carry out a literature review encompassing a focus on the factors that influence road safety, both generally and in the work context, the potential role of employers in improving work-related driving, and the potential insights that can be gained into this role through findings contained in the literature on occupational health and safety management. The second was the undertaking of new empirical research focussed on the management of work-related safety, and, more particularly, its capacity to generate safety improvements and the factors that influence this capacity, through a case study. The third was to draw out the lessons from these conceptual and empirical strands of the research for current knowledge and future research regarding employer management of work-related driving. To support these aims and objectives three types of data collection was undertaken: semi-structured interviews, focus groups and descriptive statistical data on relevant performance outcomes. The study reported in this thesis has explicitly sought to address the first of these areas of weakness.

The findings contribute to the current literature in three ways. Firstly, by shedding new light on the capacity of employers to take effective action to improve work-related driving safety. Secondly, by providing new evidence on the value of various type of employer road safety interventions. Thirdly, and more widely, adding to existing knowledge regarding the value of promulgated guidance on the organisational level management of road safety, and the challenges that confront the effective implementation of such approaches. In doing so, the study draws out and confirms often unacknowledged linkages between the literature on work-related road safety and that on workplace health and safety.

Acknowledgements

I would like to thank my supervisors Dr. John Watt and in particular Professor Phil James for his guidance and exceptional support through the process. I would like to offer a special thanks to Dr. Rachel Granger my original supervisor for all her encouragement and help. I would like to thank Eilish O Neill for her wonderful work in transcribing the interviews. I would like to offer my thanks to my colleagues in PDO Hamed Al Esry, Kamil Al Dhamri and Khalaf Al Amri for their wonderful help and support throughout the project. I would like to thank all my colleagues in Sheida International and in particular Zoran Stojanovic for his great support with obtaining and analysis of the secondary data. Lastly but by no means least I would like to thank my family, my wife Elaine, daughters Alannah and Laura for their wonderful support.

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Chapter 1: Introduction

1.1- Introduction

Road traffic accidents cause enormous harm and human suffering globally. A range of studies has been conducted on the causes of these accidents and how their number might be reduced. However, so far little attention has been paid to the role of employer policies in this regard. This study consequently provides a case study examination of the strategies and policies used by a major multinational to manage and improve road safety.

The study focuses on the oil and gas industry in Oman. Oman has a population of 4 million, made up of 2.2 nationals and 1.8 million expatriates and is considered a high-income country. The country is located in the gulf region of the Middle East, bordered on the west by the United Arab Emirates (UAE) and Saudi Arabia, the south by Yemen and the east by the Arabian Gulf. Oil and gas production constitute its main source of income, with the bulk of production exported to Asia. Oman has a road fatality rate of 17 fatalities per 100,000 population, twice as high as the average for high-income countries.

Petroleum Development Oman (PDO) is the case study organisation, and the foremost exploration and production company in the Sultanate of Oman. Its history can be traced back to 1937. Today, it operates in an area of about 100,000 square kilometres (one third of Oman's geographical area). A tripartite of Royal Dutch Shell, Total and the Omani government, PDO builds and maintains all road infrastructure within its area of operation, to which the general public has access. PDO manages in this area the road safety of its staff and contractors but has no control over the private vehicles using the roads in it.

1.2- Research context and contribution

The global road safety situation has been widely discussed in the literature, (see e.g. Toroyan, 2013; Kimber, 2005; Morris, 2006; Peden et al., 2004; Shalom and Gitelman, 2014; Tödtling-Schönhofer and Pucher, 2010; Wales, 2017; E.T.S.C, 2012; and GRSP, 2016).

The World Health Organisation (WHO) have provided a global overview Toroyan (2013) and Who (2015). These studies contain data from over 180 countries that have combined populations of 6.8 billion people, representing 98.6 percent of the global population. These data reveal that the number of road deaths annually stands at 1.24 million and that a further 20 to 50 million people sustain injuries as a result of road traffic accidents each year. Road deaths therefore constitute the eighth leading cause of death and concern has subsequently been expressed that they will rise to fifth place by 2030 unless action is taken to address the issue (Toroyan, 2013; GRSP, 2016; OECD, 2008).

Studies have shed light on the causes of road traffic accidents (see e.g. Tödtling-Schönhofer and Pucher, 2010); Shalom and Gitelman, 2014). These identify a range of factors as contributing to road accidents which are seen to fall into three main groups, namely those relating to the driver, the vehicle and the environment (GRSP, 2016). They also indicate that the road user is by far the most important contributing factor, with adverse behaviour as its most important component. In line with this, the main risk factors associated with road fatalities globally have been found to be speeding, drinking and driving, non-wearing of helmets, non-wearing of seat belts and non-use of child restraints (Toroyan ,2013). Meanwhile, research reveals a number of individual driver characteristics to be associated with the propensity to experience traffic accidents. These include various aspects of attitudes, distraction, cultural differences, a lack of training and education, and time pressures (Peden et al., 2004; Shalom and Gitelman, 2014). With regard to the influence of attitudes, researchers

have found that this can stem from rational or emotional sources, or a combination of the two. It has also been found possible to engender positive changes in driver attitudes towards seat belt wearing, and drink and driving. In contrast, however, research indicates that attitudes towards speeding and the use of mobile phones have not changed in the same way, perhaps because these behaviours are still accepted socially.

Researchers have looked at how societal and employer contexts influence road safety (Dimmer and Parker, 1999; Grayson and Helman, 2011; Warmerdam et al, 2017). For example, it has been observed that governments can influence road design, compliance with legal requirements through enforcement action, vehicle standards, and attitudes via education and campaigns (Wales, 2017). Attention has also been drawn to the role that employers can play against the background of evidence showing that work-related driving represents a significant portion of all driving and contributes significantly to road related harm (DFT, 2017; Helman, 2014; H.S.E, 2014; E.T.S.C, 2012; H.S.A, 2016 and Motus, 2018).

At the same time, relatively little literature exists on the dynamics surrounding work-based driver behaviour and its effective management. It consequently remains unclear how far these dynamics echo more general evidence concerning the causes and prevention of road accidents. Similarly, the capacity of employers to reduce work-related driving harm remains unclear, as do the factors that influence their ability to do so.

Furthermore, while a much more substantial, not to say vast, literature exists on the management of occupational health and safety more generally, including the factors that shape it, empirical uncertainty surrounds how far the key conclusions and prescriptions emerging from it are applicable to the issue of work-related driving safety (Frick, et al., 2007; Hopkins,

2006; James, et al., 2007; Robens, 1972; Robson, et al., 2007; Quinlan, et al., 2001; Quinlan, 2015; Turner, 1994; Walters, 2002; Brooks, 2001). This uncertainty moreover extends to evidence within this literature regarding the way in which such management has been challenged by the changes in the composition and structure of employment that have occurred in recent decades, notably the growing use of various forms of 'atypical' or 'non-standard' work, the weakening of collective forms of worker voice, and the greater reliance being placed by larger organisations on the externalised provision of goods and services (Benassi & Dorigatti, 2015; Nichols & Walters, 2013; Walters & James, 2020; International Labour Organisation, 2019; Frick, et al., 2007).

In short, the issue of work-related driving can be seen to be the focus of three, somewhat overlapping, sets of conceptual and empirical weaknesses. The first of these is the absence of a substantial body of research evidence concerning how it is managed, and what influences the effectiveness of such management. The second is that while the management of work-related driving can be regarded as an element of more general occupational health and safety management (OHSM), it has rarely from a research perspective been treated as an integral component of it. As a result, it remains unclear how far the findings of OHSM research can be extrapolated to the domain of work-related driving. Finally, and by extension, it similarly remains unclear how far the management of such driving has, like OHSM more generally, been impacted by the way in which work has been restructured and externalised in recent decades.

These three current areas of conceptual and empirical weakness point to a clear need for more research to be carried out on the management of work-related driving. They also highlight more particularly how such research could usefully seek to draw out similarities and differences with the OSHM literature while also more specifically embracing a focus on the way in which work-

related driving (and its management) has been impacted by the types, and changes in the world of work that have been found to create challenges to more general OHSM.

The study reported in this thesis has explicitly sought to address the first of these areas of weakness. In doing so, however, it has inevitably also shed new light on the other two. Consequently, its findings, as is explored in more detail in both the Discussion and Conclusion chapters, are argued to also contribute new and valuable knowledge in respect of them.

1.3- Aims, objectives and methodology

As already mentioned, the present study was conceived with the central aim of shedding new light on the role that employers can play in reducing work-related driving harm and the factors that influence their ability in this regard. At the same time this aim has been operationalised in a way that enables it to draw out parallels between the management of work-related driving and findings within the wider OHSM literature, including those relating to the impact of the types of employment-related changes already mentioned.

More specifically, the study has pursued its central aim through the pursuit of the following operational objectives:

- the carrying out of a literature review encompassing a focus on the factors that influence road safety, both generally and in the work context, the potential role of employers in improving work-related driving, and the potential insights that can be gained into this role through findings contained in the literature on occupational health and safety management;

- the undertaking of new empirical research focussed on the management of work-related safety, and, more particularly, its capacity to generate safety improvements and the factors that influence this capacity, through the aforementioned case study;
- the drawing out of lessons from these conceptual and empirical strands of the research for current knowledge and future research regarding employer management of work-related driving..

As already indicated, a single in-depth case study, focussed on PDO, has been carried out to fulfil the empirical element of the study. Consequently, the study has a strong applied flavour since it empirically examines how PDO manages work-related driving, the success with which it has done so, and the factors that have influenced this success, including the strengths and weaknesses of the various components of its road safety infrastructure. At the same time, however, the case study's findings, as will be seen, are argued to make a number of both conceptual and empirical contributions to the wider literature on work-related driving.

To support the case study's objectives, three types of data collection were undertaken: semi-structured interviews, focus groups and descriptive statistical data on relevant performance outcomes.

1.3.1- Interviews

Semi-structured interviews were selected for this study because they are qualitative and exploratory in nature, and allowed the interviewer to guide questioning in the areas that need to be covered, but also in a flexible and open way, and that allowed interviewees to respond in different ways. In this study thirty-five interviews were conducted among three different groups of respondents, labelled respectively the 'architects of road safety policy', the

'managerial implementers' and 'the drivers'. In the case of the present study, such interviews were primarily utilised to obtain interviewee views on the following issues:

- What have been the main drivers of PDO policies and procedures on road safety?
- How well are they understood and implemented?
- How is this implementation monitored?
- What factors have influenced the implementation of these policies and procedures?
- What improvements in existing policies and procedures are considered necessary?

1.3.2- Focus groups

Focus groups were used in this study to supplement the qualitative data gather through the and in doing so providing a form of triangulation. Given these virtues, along with the fact that the researcher is trained and experienced in leading group discussions, it was concluded that a small number of focus groups could be valuably used alongside the intended semi-structured interviews. The four focus groups were made up of the same respondents mentioned above, the architects, implementers and drivers. More particularly, it was decided to use such groups to discuss a range of operational issues relating to laid down policies and procedures concerning Journey management, Driving, Driver training, Vehicle standards, Loading and load security, commuting and In Vehicle Monitoring System (IVMS).

1.3.3- Statistical data

Another important element of the study's methodology involved the compilation and analysis of PDO descriptive statistical data. This analysis proceeded in two stages. In the first part attention was paid to trends in road safety performance assessed in terms of both safety outcomes and various operational indicators. These included Motor Vehicle Incidents (MVI'S), Lost Time Incidents (LTI's), Total MVI injuries, and a comparison of work- and

non-work-related fatalities. In the second, the factors that appear to have influenced this performance were reviewed. These included In Vehicle Monitoring System (IVMS), 'Hearts and Minds' campaigns (driver forums, rollover and seat-belt simulation, tyre safety, driver fatigue and behaviour), policies and procedures, enforcement by the Road Safety Standards Body (RSSB) and proactive measures taken by the RSSB in terms of vehicle inspections.

1.4- Thesis structure

The rest of the thesis comprises six chapters that respectively provide a review of relevant literature, outline the study's methodology, provide background information on the case study organisation, detail the quantitative and qualitative findings obtained, and discuss these findings in relation to existing theory and empirical analyses. Below more information on the contents of these chapters is provided.

The next chapter provides a review of existing, relevant literature, initially looking through the lens of the overall aim and supporting objectives of the thesis. The chapter comprises of three parts and a conclusion. The first section examines the scale of driving harm, and compares road deaths to other causes of death and harm, with comparisons drawn between high, low and middle-income countries. It explores the role that unsafe driving plays in road accidents relative to the other main contributors, namely the vehicle and road and weather conditions. It then goes on to discuss the types of behaviour that cause driving harm and the main categories of factors that influence their occurrence. The second part focuses on work-related driving harm and the role played by the employer. It examines the importance of driving for work, the scale of work-related harm and its causes. Recommendations and guidance available to the employer on managing their road safety are discussed. Evidence regarding the role of the employer in reducing work-related driving harm as well as issues faced by them are further discussed.

Attention in the third part is then paid to highlighting parallels between these recommendations and those found in the wider OHSM literature and what this literature tells us about the factors that influence their effective operationalisation in the context of the changes that have been occurring in the world of work over recent decades. Finally, the main conclusions arising from the literature reviewed are drawn together and used to highlight the contribution that the study can make to existing knowledge and understandings.

The next chapter details the methodological choices that have shaped the empirical components of the study and the way in which they have been operationalised. It does so in the context of the study's aim, namely to evaluate the implementation of a road safety strategy by a multinational in the context of the multi-cultural environment of Oman, and its supporting objectives. The chapter is divided into three main sections. The first focuses on explaining and justifying the decisions made with regard to the adoption of an inductive, interpretivist approach to the study, the choice of a single case study research design and the data collection methods it was decided to utilise. The second section then moves on to detail how these methodological choices have been operationalised. Finally, the third section addresses the issue of the study's compliance with good ethical standards.

The following chapter provides an introduction to the case study organisation, Petroleum Development Oman (PDO). It begins by providing brief outlines of the organisation's history and the national context within which it operates and manages road safety. It then moves on to detail the structural and policy infrastructure established for the management of such safety. It discusses PDO's safety philosophy of 'Goal Zero' which is to cause no harm to people, assets or the environment and how it is supported by twelve Life Saving Rules (LSRs) and three 'Golden Rules'. Following this, the chapter goes on to discuss PDO's two main road safety

documents, SP2000 and SP2001. The first of these is noted to set out minimum road safety standards in order to manage and reduce the risk associated with road transportation. The second to outline policies and procedures relating to the load security of heavy vehicles and equipment.

The next chapter examines the road safety performance of PDO using internally available secondary data, mainly for the period 2008 to 2016. The analysis also proceeds in two stages. In the first part attention is paid to performance in terms of both safety outcomes and various operational indicators while the second is devoted to identifying the factors that appear to have influenced these measures of performance. In the first area attention is focused on Motor Vehicle Incidents (MVI's), Lost Time Incidents (LTI's), Total MVI injuries, and a comparison of work- and non-work-related fatalities, as well as four types of operational defects, classified respectively as A, B, C and D, along with the extent of compliance with the previously mentioned Life Saving Rules (LSR's). In the second area, discussion focusses primarily on the possible influence on performance exerted by five different types of interventions: IVMS, hearts and minds campaigns, defensive driving, enforcement and pro- active measures by the RSSB.

In the next chapter interview and focus group data are drawn upon. The analysis of these proceeds through three stages. In the first, knowledge and understanding of the organisational rules and procedures related to driving is explored. In the second compliance with these rules is examined. In the third, areas that could be improved are discussed. Within each of these discussions distinctions are drawn between the responses of three different groups of respondents, labelled respectively the 'architects of road safety policy', the 'managerial implementers' and 'the drivers'.

The following chapter seeks to bring together the theoretical and empirical parts of the thesis. It starts by reviewing the academic context and rationale for the undertaken study. Following this, the chapter outlines the main findings obtained, considering in turn the light they shed on PDOs road safety management, performance and the factors that influenced it. Challenges faced by PDO on its road safety journey as well as areas for improvement are highlighted. Finally, attention is paid to the implications of these findings for existing knowledge and literature.

Chapter 2: Literature Review

2.1- Introduction

Road traffic accidents cause enormous harm and human suffering globally. A range of studies has consequently explored the causes of these accidents. In this chapter, a review of the resulting literature is undertaken in the light of the overall aim and supporting objectives of the thesis. The chapter comprises of three main parts, followed by a conclusion.

The first part examines the scale, causes and prevention of driving harm. It compares road deaths to other causes of death and harm, and how this harm varies between high, low and middle-income countries. It further explores the role that unsafe driving plays in road accidents relative to the other main contributors, namely the vehicle and road and weather conditions. It then goes on to discuss the types of behaviour that cause driving harm and the main categories of factors that influence their occurrence. Finally, various forms of road safety prevention along with government action are discussed.

Part two subsequently focusses more specifically on work-related driving harm. First, it examines the importance of driving for work, the scale of harm associated with it, and the causes of this harm. Attention is then paid to recommendations put forward regarding how employers should approach the management of driving safety. Following this, existing research evidence relating to the role of employers in reducing driving harm is reviewed.

Part three then moves on to explore where the road safety literature stands in relation to the wider OHSM literature. More specifically, it draws out parallels between the management prescriptions to be found in these two literatures, and draws out from the OHSM one the factors

that have been found to influence the operation and effectiveness of systems for manging work-related risk.

Finally, the main conclusions arising from the literature reviewed are drawn together and used to highlight how the present study can contribute to existing knowledge and understandings.

Part 1: Scale, causes and prevention of driving related harm

2.2- Scale of driving harm

According to the World Health Organisation (WHO), 1.24 million people are killed every year and a further 20 to 50 million people are injured as a result of injuries sustained in road traffic accidents (D.F.T., 2017; Toroyan, 2013). The same study shows an average road fatality rate of 18 fatalities per 100,000 population, with the figures for high-, middle- and low-income countries being 8.7, 20.1 and 18.3 respectively (see further below). These figures are, however, averages. Thus, within these groupings rates can vary significantly. For example, in the high-income category, Sweden has a fatality rate of 2.8 per 100,000 population, while that for Oman is 17 fatalities per 100,000 population (GRSP, 2016).

Road accidents account for 2.2 percent of deaths globally. Deaths related to road injury exceed those from many other causes, such as hypertensive (heart attacks associated with high blood pressure), preterm birth, tuberculosis and some forms of cancer (WHO, 2014). They are also only marginally lower than those arising from diabetes, HIV/AIDS, lung cancer and diarrhoeal diseases. Nevertheless, the main causes of death globally remain heart disease and strokes, which kill 7.4 million and 6.7 million people respectively each year (WHO, 2014).

Toroyan (2013) used gross national income (GNI) to band countries into categories of low, middle and high-income. He then examined the rates of accidents for high-, middle- and low-income countries, and discusses variations in the types of accidents within these groups. According to Toroyan (2013), middle-income countries account for 80% of all road related fatalities, followed by low-income at 12% and high income at 8%. The figure of 80% in relation to middle-income countries is disproportionally high relative to the level of motorisation in these countries. There are variations in the type of accidents within these groups. For example, in middle-income countries 38% of all road deaths were among pedestrians, contrasting sharply with 22% in high-income countries. Another example of the variances is that approximately 50% of road deaths are among car occupants in high-income countries, contrasting with approximately 30% in middle- and low-income countries (Toroyan, 2013). Meanwhile, lower income countries have the highest proportion of deaths among vulnerable road users (pedestrians, cyclist and motorcyclists combined) at 57%, a figure which contrasts with 51% in middle-income and 39% in high-income ones.

2.3- Causes of driving harm

A host of studies have examined the causes of road traffic accidents (see e.g. Clarke et al., 2002; Cuerden et al., 2011; Hamilton and Kennedy, 2005; Bener and Crundall, 2005; Broughton et al., 2010; Kimber, 2005; Lloyd et al., 2013; Mohan et al., 2006; Plankermann, 2013; Shalom and Gitelman, 2014; Treat et al., 1979; R.S.A., 2011; Bambach et al., 2012; Richards et al., 2010; C.O.N.R.O.D., 2011; and Twisk, 1995). These studies identify a range of factors as contributing to road accidents that can be seen to fall into three main groups, namely those relating to the driver, the vehicle and the environment. The studies also show similar patterns concerning the relative importance of these categories of causal factors. For example R.S.A. (2011) shows the breakdown for Ireland as 91% road user, 3% vehicle and 6%

environment, while similarly for the UK Richards et al. (2010) show the road user at 94%, vehicle at 2% and road and weather at 4%.

Below this evidence concerning the factors that contribute to road accidents is examined in more detail by focusing attention on the major studies undertaken in three different countries, the United Kingdom (UK), Australia and Dubai. These countries have in part been chosen on the basis that they enable comparisons to be drawn across three high-income countries. In addition, the inclusion of Dubai relates to a geographical country for which reliable data exists and which serves as a useful benchmark in relation to driving safety in Oman. The issue of data quality also explains why the focus is on Dubai, rather than the entire UAE.

2.3.1- UK study

The UK currently has one of the lowest road fatality rates globally at three fatalities per 100,000 population. In what follows, attention is focused on a study undertaken by Richards et al. (2010) since this constitutes the most comprehensive analysis undertaken in the UK. This study drew on data from two databases - STATS 19 (UK's national database of reported road traffic collisions involving personal injury) and OTS (a database established from a study involving on scene collision investigations in two geographical areas).

An important objective of this study was to compare the contributing factors in each database for the same accidents and to use these comparisons to better understand the causes and consequences of accidents, and in this way aid the government in trying to develop countermeasures (Richards et al, 2010). The two databases were used because they were seen to have complementary advantages and disadvantages. STATS 19 records a large number of

accidents but does not provide in-depth information about them, while the OTS study investigated a smaller number of accidents but examined each one in greater depth.

The OTS study ran from 2000 to 2010 in the geographical areas of Nottinghamshire and Thames Valley. Across those two geographical areas between 2000 and 2006 there were 34,242 accidents recorded in STATS 19 and 3,102 recorded in OTS. There was an overlap of 1,555 accidents recorded in both systems which met the criteria for the study.

Linking the data recorded on these overlapping accidents enabled the influence of 77 potential contributory factors to be explored in relation to 482 accidents that occurred over the period 2005 to 2006. These contributory factors were grouped into nine different types. Six of these are directly concerned with the road user contribution, namely injudicious action, driver/rider error or reaction, impairment or distraction, behaviour or inexperience, vision affected by external factor and pedestrian error. A further two related to vehicle defects, and the road environment including the weather. One further type was added to capture a factor that did not fit the above mentioned groups.

When the STATS 19 database was analysed, it showed 90% of these accidents related to road user error, while vehicle defects accounted for three percent and the road and environment accounted for a further seven percent. When the contributory factors of the same 482 accidents were analysed in OTS it similarly showed that road user error accounted for 94%, vehicle defects for two percent and the road and weather for four percent.

The figures from the two databases consequently revealed rather similar patterns. Richards et al. (2010) therefore confirm the findings of previous studies (Hamilton and Kennedy, 2005;

Bener and Crundall, 2005; Kimber, 2005; Mohan et al, 2006; Treat et al, 1979; Twisk, 1995 and Clarke et al. 2002) by identifying the three main contributing factors to road traffic accidents as road user, the vehicle, and road and weather. The study also confirmed that the road user was by far the largest contributory factor. Richards et al. (2010) also point out, however, that all of the accidents were multi-causational, with an average number of contributory factors of 2.5 in STATS 19 and 3.7 in OTS.

2.3.2- Australian study

Australia is regarded as a leading country in terms of the management of its road safety, having led in terms of legislative changes to improve road safety, including through the introduction of a zero-blood alcohol concentration (BAC) for young, novice and professional drivers. As Australia's National Road Safety Strategy 2001–2010 outlined, the goal for the country during this period was to reduce the number of road fatalities by 40% to not more than 5.6 per 100,000 population in 2010. This goal was achieved, resulting in a road fatality rate of 5.34 per 100,000 population (B.I.T.R.E, 2016).

A study undertaken by B.I.T.R.E (2011) provides the most detailed examination of road safety harm in the country. This examined 8305 fatal crashes in Australia between 1990 and 2009 recorded in the Australian National Fatal Road Crash Database. The study's findings shed light on the prevalent crash types during this period, the major factors contributing to them and the road user groups most frequently involved. Like most other studies, the major factors are categorised in relation to the road user, adverse weather conditions and vehicle malfunction or defect (B.I.T.R.E, 2011). In addition, the findings obtained reveal a similar pattern regarding their contribution to the occurrence of accidents.

Over the period 1990 to 2009, the road user was a major factor in 87% of all fatal crashes, while this was the case for adverse weather and vehicle defects in eight and five percent respectively. The study went on to examine the various road user factors in detail, breaking them down into impairment (alcohol or drugs), fatigue, driver error and distraction, excessive speed and other risk taking. Driver error, excessive speed and impairment (alcohol or drugs) remained the three most frequently recorded major factors between 1990 and 2009. What was also noticeable in the study was a spike in driver distraction around 1998, when, out of 1453 fatal crashes, it alone was a factor in 52% of them. The authors speculate that this spike could have been the result of the global upsurge in mobile phone use around this time, while its subsequent reversal (to 39%) could be a reflection of the introduction of new laws on the usage of such phones and their enforcement.

2.3.3- Dubai study

Al Dah (2010) conducted a study on the causes and consequences of road traffic crashes in Dubai, which is part of the UAE. Dubai was found to have a road fatality rate of 10.9 per 100,000 population in 2013 (WHO, 2015). The main objectives of the study were to analyse crash data to establish a baseline for the factors in accident causation in Dubai, and to assess the suitability of potential countermeasures.

The data used for the study were obtained from the Dubai Police and the Roads and Transport Authority (RTA) and covered a twelve-year period from 1995 – 2006. Of the 18,113 crashes examined, the road user was found to be the main factor at 85%, followed by the vehicle at 6% and road conditions at 9%. Further analysis of the road user factor revealed that the most prominent cause, at 26%, was lack of consideration for other road users. This was followed by

speeding at 12.6%, and entering a carriageway without checking for traffic at 11.3%, (Al Dah, 2010). A similar picture emerged when the crashes for 2006 were analyesd seperately.

Other Middle-Eastern studies reveal similar figures. For example, Bener and Crundall (2005) found driver error to be a factor in 94.3% of all crashes, followed by the vehicle at 5.1% and the environment at 6%, while Hammoudi et al. (2014) found driver error to be a factor in 98% and vehicle defects in 2%.

Reflecting on the three studies discussed above (Richards, 2010; B.I.T.R.E., 2011; and Al Dah, 2010), it is evident that in each of them the three main factors in road traffic crashes were found to be features of the road user, the vehicle and the environment. Although the three studies were conducted in different regions with different population sizes and road traffic fatality rates, they nevertheless reveal similar percentages for each of the main contributory factors. What is also very evident in all the studies is that is the driver is by far the greatest contributor.

Having said that, it is important to reiterate the point that most road traffic accidents are multi-causational (Richards et al, 2010).This means that it is extremely rare for one of the three main factors alone to be one hundred percent the cause of an accident. For example, a driver could have been speeding on a wet road with bad tyres. Were any one of these factors to be absent, then an accident might not have occurred.

2.4- Types of behaviour causing driving harm

It is then evident from the available evidence that driver behaviour is the most significant proximate factor leading to driving harm. A range of studies, as already noted, point to this (see e.g. Richards, 2010; B.I.T.R.E., 2011; Al Dah, 2010; Clarke et al., 2002; Cuerden et al.,

2011; Bener and Crundall, 2005; Hamilton and Kennedy, 2005; Broughton et al., 2010; Kimber, 2005; Toroyan, 2013; Tranter, 2010; Wegman et al., 2005; and Treat et al., 1979). In this section attention now turns to the different types of behaviour involved in this harm.

An examination of the studies referred to above reveals that they generally distinguish between nine different road user factors: alcohol/drugs, fatigue, driver error/distraction, excessive speed, behaviour or inexperience, careless actions ond other risk taking. Since five of these seven factors are common to all three studies in what follows more detailed attention is focussed on those, namely speeding, impairment, non wearing of seat belts, distraction and reckless driving.

2.4.1- Speeding

It is well documented in the literature that speed is a major factor leading to driving harm globally. Clarke et al. (2002), for example, identifies speed as a factor in 33% of fatal road traffic accidents in the UK. In Australia, B.I.T.R.E (2011) similarly reports speed to be a factor in 28% of all fatal road accidents. The Dubai study (Al Dah, 2010) meanwhile found speed as a factor to be a lower percentage than the other countries at 12.6% of all road traffic crashes. Meanwhile, R.O.P. (2015) shows speed to be a factor in 52% of all road traffic accidents in Oman. Toroyan (2013) further supports these studies, listing speed as one of the five major risk factors leading to death or injury globally

One criticism of the quoted studies, however, is that they make little distinction between drivers breaking the speed limits and drivers driving too fast for the conditions. Nor do they break down the role of speeding by the age group of the drivers (see e.g. Cuerden et al, 2011; Lloyd

et al, 2013; Plankermann, 2013; Shalom and Gitelman, 2014; R.S.A. 2011; Bambach et al, 2012; and CONROD, 2011)

2.4.2- Driving while Impaired

Driving while impaired is considered to be when a driver is under the influence of drugs or alcohol. In research undertaken by Broughton et al. (2010), driving when impaired was identified as a major factor in 12% of all accidents and 22% of fatal ones in the UK; findings that receive support from the studies undertaken by Kimber (2005) and Clarke et al (2002). B.I.T.R.E (2011) rather similarly reports driving while impaired to be a factor in 33% of all fatal accidents in Australia. In contrast, in relation to Dubai, Al Dah (2010) shows impairment as a factor in just one percent of all accidents.

The above rates suggest that the role of impaired driving varies significantly from region to region, presumably as a result of cultural differences. Having said that, the World Health Organisation (WHO) lists drinking and driving as one of the five major risk factors internationally (Toroyan, 2013).

A criticism of these reports is that there is no differentiation between drugs and alcohol as they are clubbed together. It would be interesting to know whether the percentage of alcohol related accidents is increasing or decreasing to ascertain how far the drinking driving measures introduced have been effective. For a similar reason, the age profile of those involved in drug related road traffic fatalities could help assess which groups should be the focus of interventions in this area.

2.4.3- Non-wearing of seat belts

Seat belt and non-seat belt wearing are not causes of road traffic accidents. However, the issue is discussed here because it does shed some additional light on compliance with road safety requirements and hence attitudes towards them.

Non-wearing of seat belts is listed by WHO as another of the five major risk factors associated with road traffic death and injury globally. It is suggested by Evans (1996) that the implementation of seat belt wearing laws since the 1970's saw the greatest reduction in driving related harm through the behavioural change it induced. Further estimates show that between 1980 and 2004 300,000 lives and nine million injuries were saved as a result of the implementation of laws regarding seat belt wearing (WHO, 2004). In line with this, it is widely agreed that wearing seat belts reduces harm to the occupants by between 60 to 75% (Mohan et al. 2006; Evans, 1996). Nevertheless, according to R.S.A. (2013), 17% of vehicle occupants killed on Irish roads in 2013 were not wearing their seat belt.

2.4.4- Distraction

Driver distraction is a relatively new problem affecting road safety and the extent of the problem does not appear to be fully understood. Distraction and its effects are well described in G.H.S.A. (2011) and E.T.S.C. (2012). Basacik et al. (2011) suggest that mobile phones appear to present the greatest distraction to drivers, while Mayhew et al (2013) argue that this has become worse since the introduction of the smart phone.

Some countries have now begun collecting data on distraction as a factor in road traffic crashes, although current data remains relatively sparce. B.I.T.R.E (2011) cites distraction and impairment as a factor in 38% of fatal crashes in Australia, and Broughton et al. (2010) found

it to play a role in 26% of those in the UK. A criticism of these studies, however, is that distraction and impairment are grouped together, making it difficult to determine their separate contributions. Consequently, Toroyan (2013) suggests that the prevelence of mobile phone usage while driving is still largely unknown. There is nevertheless some empirical evidence that using a mobile phone while driving does lead to driving harm (Strayer et al., 2006 and Basacik et al. 2011). Strayer et al. (2006), for example, compared a driver driving at the legal limit of alcohol and a driver using a mobile, and concluded that they presented a similar risk.

2.4.5- Reckless driving

Reckless driving is another behaviour that can lead to driving harm. Broughton et al. (2010) state that 32% of all accidents in the UK involve reckless driving . Similar figures are shown by Clarke et al. (2002). Similarly, in Oman, according to R.O.P. (2015), reckless driving accounts for 22% of all accidents, while Al Dah (2010) shows it as a factor in 26% of accidents in the UAE. Meanwhile, in Australia, Bitre (2011) found reckless driving to be a factor in 38% of fatal crashes. A criticism of these studies though is that it is not made clear what acts of driving constitute wreckless driving. Broughton et al. (2010) and Clarke et al. (2002) do though distinguish between reckless driving and driving error, and hence suggest that reckless driving is something that is done intentionally. This would suggest that driver attitudes significantly contribute to reckless driving (see further below).

In summary, then, the evidence reviewed in this section has highlighted that driver mis-behaviour is by far the greatest contributing factor to road traffic harm. This section has pointed to some of the particular behaviours that cause this harm. Speeding has been identified as a factor in approximately 30% to 50% of fatal motor vehicle accidents, while driving while impaired presents as a factor in 12% to 30%. Despite general improvement in seat belt wearing,

non-wearing in some regions remains problematic. Mobile phones remain the greatest cause of driver distraction, a trend that has worsened since the introduction of the smart phone, and although data is sparse on its use as a factor in road traffic harm, some countries have identified the phone's contribution to be as much as 38%. Reckless driving meanwhile has emerged as another important factor, evidence suggesting it accounts for between 22-38% of fatal motor vehicle accidents.

2.5- Causes of driving (mis-) behaviour

In the previous section we discussed the types of behaviour that can cause driving harm. In this section we will now explore and discuss some of the causes of the driving (mis-) behaviours mentioned in the previous section. Numerous studies have been conducted on the causes of driving harm (Toroyan, 2013; Koornstra et al, 2002; Özkan et al, 2006; May et al, 2008; Petridou and Moustaki, 2000; McAndrews, 2013; Nordfjærn et al, 2012; Şimşekoğlu et al, 2012; Tranter, 2010; Wegman et al, 2005). Petridou and Moustaki (2000) have broken these causes down into four groups. The first group are those that reduce capacity on a long-term basis such as inexperience, aging, disease and disability, alcoholism and drug abuse. The second group are those that reduce capacity on a short-term basis such as fatigue, short term drug and alcohol effects, temporary distraction and stress. The third group are those that promote risk taking behaviour with long-term impacts such as macho attitude, overestimating of capabilities, habitual speeding, habitual disregard for traffic law, indecent driving behaviour and non-use of seat belts or helmets. The fourth group are those that promote risk taking behaviour with a short-term impact such as psychotropic drugs, motor vehicle crime, suicidal behaviour and compulsive acts (Petridou and Moustaki, 2000). For the purposes of succinctness, however, they are discussed through the lens of a number of (admittedly somewhat overlapping) aspects of drivers and and their contexts, namely attitudes to driving,

perceptions of risk, the influence of surrounding cultures, anti-social motivation, fatigue, a lack of training and education, and time pressures.

2.5.1- Attitudes

Driver attitudes and the role they play has been widely discussed in the literature (see e.g. Ulleberg and Rundmo, 2003; Dimmer and Parker, 1999; Goldenbeld et al., 2000 and Haley, 2006). In relation to driver behaviour, Haley (2006) suggests that the problems with attitude originate with a person's personal beliefs relating to driving and road safety. He goes on to say that knowledge and beliefs work together and influence all of a person's thinking, not just part of it. Hayley (2006) discusses some of the suggested beliefs in terms of driving and road safety. The suggested beliefs relate to how the driver perceives the importance of some of the critical elements of safe driving, such as levels of concentration, distraction, tolerance, risk, courtesy and decision making. Further beliefs relate to individual perceptions of skill levels and the learning required to reach these levels. Other beliefs relate to the ownership of responsibility and blame. These beliefs towards driving and road safety then manifest as attitudes. Such attitudes are therefore intimately connected to the more specific causes of poor driving behaviour discussed below.

2.5.2- Risk perception

Risk perception has been found to vary considerably between different drivers and as a result of a variety of influences. SARTRE (2004) conducted a survey on European drivers caught speeding and questioned them about why they speed. Some of the responses pointed to temporary considerations (e.g. "I'm in a hurry"; "I didn't know the speed limit"). Others pointed to the influence of longer-term ones (e.g. "I'm more skilled that other drivers so can drive faster and still be safe"; "This car is designed to be safe when driven fast"). A range of

other factors were also found to potentially influence behaviour in terms of speeding. Drivers of powerful cars suggested that they tended to drive faster as they felt safer. They also reported that they tended to drive faster on roads where it was felt that the likelihood of being caught was low. The same drivers suggested that the posted speed limit was a target that must be reached regardless of the prevailing conditions. The presence of passengers in the vehicle was a further factor that appeared to have an influence of drivers speeding. In particular younger drivers tend to drive faster when they have passengers in the vehicle, possibly due to peer pressure (SARTRE, 2004).

The study further found that male drivers more commonly reported that they enjoyed driving fast. The same was true of younger drivers, single people, those living in urban environments and those employed with a higher income (SARTRE, 2004). Meanwhile, an Austrailian study (A.T.S.B, 2006) found that there was a belief among some of those interviewed that good drivers should be able to set their own speed limits.

The study notes in particular that the behaviour and perceptions associated with driver speed is glamorised by the motor industry, motor racing and in advertisements. Whilst motor racing is undertaken in controlled and safe environments, it was argued that many drivers', in particular young males, cannot see the distinction between the racetrack and the public road. Studies, such as those by Strayer et al. (2006) and Basacik and Robbins (2009), suggest that the mobile phone presents the greatest distraction to a driver and compares the risk as similar to that of a driver driving at the legal limit of alcohol. Despite goverement campaigns highlighting the risks associated with its use, and laws and penalty points in place, drivers still continue to use their phones while driving. This further demonstrates the power of beliefs, namely the risk is not percieved or is ignored. Gardai (2014) shows that in 2014 30,514 Irish

drivers were fined for using a mobile phone while driving compared to 7697 convicted for drinking and driving. It would appear, like speeding, that using a mobile phone while driving is still socially acceptable.

Other studies point in a similar direction of risk perception. Kayani et al. (2011) conducted a study on fatalism in relation to road safety in developing countries, with a particular focus on Pakistan. Whilst they did not confirm that fatalism was associated with road traffic accidents, their findings suggested that it acts as a barrier to the success of public health messages aimed at road crash prevention and constitutes an area in which further research is required. In subsequent qualitative research, the same authors further describe how fatalistic beliefs relating to road safety exist in other developing countries, such as Ivory coast (West Africa), Nigeria and Thailand.

2.5.3- The influence of culture

Studies such as (Nordfjaern et al., 2014; Şimşekoğlu et al., 2012 and Özkan et al., 2006) have explored the influence of risk culture on driver behaviour. Şimşekoğlu et al. (2012) examined traffic risk perception, and road safety attitudes and behaviours among road users in Turkey and Norway. Norway is a high-income country with a road fatality rate of 4.3 per 100,000 population. Turkey is a middle-income country with a road fatality rate of 12 per 100,000 population.. The Turkish respondents reported positive attitudes towards drinking and driving, while Norwegian respondents exhibited safer attitudes towards speeding. However, it seemed that Turkish respondents engaged less frequently in speeding behaviours, while their Norwegian counterparts reported a lower frequency of drinking and driving. The study's findings therefore not only pointed to national differences in driving attitudes and behaviours, but also highlighted contradictions between expressed attitudes and reported behaviours.

In a rather similar vein, Nordfjaern et al. (2014) found that Norwegians reported safer attitudes towards road safety than participants from Sub- Saharan Africa, Turkey, Iran, Russia and India. More generally, the study found cultural factors to be strong predictors of driver behaviour than of risk perception. It was suggested that established cultural theories may benefit from a broader focus rather than mere predictions about traffic risk. Furthermore, the study suggested psychological campaigns that promote safer attitudes and behaviours are needed, particularly in Iran.

There are also grounds to believe that societal attitudes can change in a way supportive of road safety. Thus, in the case of drinking and driving, Stewart and Sweedler (2008) note that over the past 30 years it has declined by 50% in the UK and by 37% in Australia. These declines are seen to have reflected a combination of the introduction of new laws along with their enforcement, as well as greater public awareness of the potential consequences of drink driving. In contrast, May et al. (2008) acknowledges that a societal attitude adjustment is required to challenge and change 'the culture of speed'

2.5.4- Anti-social motivation

Previous research has suggested that a degree of anti-social motivation may play an important role in traffic accident causation, not only in extreme cases involving the commission of dangerous and illegal manoeuvres but across the board among the general population (West, 1997). West (1997) discusses the cross-cultural generalisability of a relationship between anti-social motivation and traffic accident risk. The results supported the proposition that anti-social motivation is positively associated with road traffic accidents not only at the extremes but also more generally.

2.5.5- Fatigue

It is clear from the available evidence that fatigue is a major factor in road traffic accidents. For example, NHTSA (2008) showed fatigue to play a role in approximately 20% of all road traffic accidents in the US, while similar findings have been obtained in other studies (CARRS-Q, 2011; R.S.A., 2008).

Lim and Chia (2015) have discussed some of the possible causes of fatigue, such as ageing, difficulties in adjusting circadian rhythms due to shift work, long working hours, medical conditions, excessive caffeine intake, poor sleep quality and long hours of driving. Commercial drivers such as heavy truck drivers, sales representatives and taxi drivers have been found to be particularly susceptible to fatigue (Gander et al., 2011; Haworth, 1998).

While most countries have laws in place to limit the number of hour's heavy goods vehicles and bus drivers may drive, the same is not true for taxi drivers and others that drive as part of their work. According to RSA (2008), evidence suggests that tiredness related collisions are three times more likely to result in death or serious injury, and that fatigue related driving injuries are more likely to occur between two and six am, and between three and five pm. The fact that fatigue was further found to be, on average, a factor in approximately 20% of road traffic accidents highlights the severity of the problem.

A study conducted by Quinlan (2001) into the truck driving industry in Australia highlights that use of performance based payment systems leads to illegal driving practices, which enable cost savings to be made. The study highlighted that fatigue was a main concern in the long-haul industry, increasing the risk of collision as well as other adverse health effects. For

example, between 1993 and 1998 fatigued truck drivers accounted for 80% of casualty crashes in New South Wales.

2.5.6- Lack of Training/Education

Traditionally driver education and training was seen as the solution to road safety. In the early days of the motor vehicle, there was no requirement for the driver to hold a driving licence and to pass a competency-based test to obtain one. Over the past decades, this has changed across much of the world.

Haley (2006) discusses how the intellectual skills of a driver, such as observation, anticipation and risk perception are an integral part of the driving process which can reduce the risk of being involved in a road traffic accident. However, much of the present day learner driver syllabus still focuses on the technical skills (basic vehicle control) rather than intellectual ones. Macdonald (1987), for example, has noted that current driving tests primarily examine vehicle control skills and to a much less extent perceptual and cognitive ones.

2.5.7- Time pressures

Time pressure plays an important role in road safety. For example, looking at work pressure, Tranter (2010) discusses how some drivers have a misguided perception that they are saving time by increasing their speed. The Australian Association of Motor Insurers (AAMI) conducted research into driver behaviour (A.A.M.I., 2005). The study shows that 44% of drivers surveyed admitted being involved in road rage and a further 33% admitted they speed to get to work or home sooner. More generally, research carried out over the years suggests that drivers who drive for business are at higher risk of being involved in an accident, relative to the general driving population (Clarke et al, 2005). This is further supported by Lynn and

Lockwood (1998), who found that, even after taking higher mileage and demographic variables into account, company car drivers were 49% more likely to be involved in an accident than ordinary drivers. Grayson (1999) reaches a similar conclusion, while noting that the reasons for company car drivers being at higher risk are still poorly understood. Time pressures are, however, thought to play a role, as well work schedule, fatigue, larger engine size, and psychological characteristics such as aggression and extroversion (Clarke et al, 2005). A further factor is suggested to be the reduced personal costs of accidents, where the costs associated with an accident are absorbed by the company and not by the driver.

Broughton et al. (2003) found car drivers that drove more than 80% of their annual mileage on work related journeys had 53% more accidents than drivers who drove no work related mileage. In the same study, work related drivers admitted to driving under pressure to reach specific destinations on time. They also admitted to performing distracting tasks while driving such as eating, drinking and engaging in mobile phone conversations. Adams-Guppy and Guppy (1995) reported that 50% of the 572 drivers in their sample admitted often driving at least 10 mph over the speed limit. These drivers viewed being on time for appointments as desirable, while being less likely to view speeding as a risk factor. Clarke et al. (2005) has therefore argued in the light of such evidence that organisational measures are needed to reduce perceived time pressures within business vehicle users (see further below).

In this section some of the causes of driving misbehaviour were identified and discussed. It was revealed that drivers' beliefs can influence a drivers attitude, both positively and negatively, and consequently driving behaviour. Inappropriate risk perceptions were found to contribute to such bad driving behaviours as speeding and mobile phone use while driving. Cultural beliefs, which vary globally, were further identified as causes of both positive and

negative driving behaviour. Similiarly anti-social motivation was found to be positively associated with road traffice accidents. Evidence, it has been noted, further suggests that driver fatigue is a major concern globally with it being a factor in approximately 20% of all road traffic accidents. Finally lack of driver training and education, as well as time pressures, were identified as two further causes of driver mis-behaviour. Time pressure in particular emerged as a proportionally high factor among drivers that were driving as part of their work.

2.6- Road safety prevention and governmental action

The evolution of road safety research from the early years of motorisation until the present day has usefully been traced by Shalom and Gitelman (2014) in the following table. It can be seen from this that research has evolved from a focus on single causes to a multi-causational approach that can be seen to allign with the evidence that road traffic accidents are often multi-causational (Broughton et al, 2010; Richards et al, 2010).

Table 2.1 – Periods of RS research, according to various perspectives. Shalom and Gitelman (2014)

Time line

Perspective of consideration	Early years of motorisation	1950-1960s	1970-1980s	1990s	2000s
Road safety management (OECD, 2008	n/a	Focus on driver interventions	Focus on system-wide interventions	System-wide interventions, with targeted results and leadership	Safe-system approach
Road safety research paradigms (OECD, 1997)	Vehicle control; descriptive research ("what") Road	Mastering traffic situation ("why"); research around the classical 3E's Engineering, Education, Enforcement	Managing the traffic system ("how"); mathematical models; cost benefit analysis Mastering	Managing the transport system; multidimensional analysis	Cross-disciplinary analysis; theory development

Main road crash causes Wegman et al. (2007)	Crashes as a chance phenomenon	Crashes are mono-causal Crashes caused by the crash-prone	A combination of crash causes fitting within a 'system approach'	The road user is the weak link: more behavioural influence	Better implementation of existing policies; Systems' management perspective The

More specifically, the rise of widespread motorisation in the 1950s and 60s was accompanied by a research focus on the driver and more particularly on the nature and causes of accident proneness. Doubts about the value of this notion, however, led to the gradual evolution of a broader systems approach (see e.g. Haddon et al, 1964).

The systems approach looks at the driving and road system as a whole and examines the interaction between its different components. The approach firstly considers the components, of the system, namely the road users, the vehicle and the environment. From there, the systems approach considers the desired outputs of the road transport system in terms of the different types of desired trips, the risk factors associated with them and how they can be minimised through actions aimed at the road user, the vehicle and the environment. It also examines undesired outputs, such as road traffic injuries, pollution and congestion, and how these can be best managed when they do occur.

The Haddon matrix is considered the first example of a systems approach to road safety and usefully illustrate the more general nature of such approaches (Haddon, 1972).The matrix has three phases and three corresponding factors that affect each phase. The three phases are pre-crash, crash and post-crash, and the corresponding factors are human, vehicle and environment.

2.6.1- Pre-crash

The pre-crash phase of the matrix is aimed at crash prevention. Some of the factors considered relating to the human element are driver attitudes and impairment, and police enforcement. Factors considered in relation to the vehicle include lighting, braking and speed management, while those listed in respect of the environment encompass road design, road layout, speed limits and pedestrian facilities.

2.6.2- Crash Phase

In the crash phase the matrix focuses on injury prevention when a crash does occur. Some of the human factors considered are the use of restraints and seating position. Some of vehicle factors considered are occupant restraints, other safety devices (such as airbags) and crash protection design. Finally in terms of the environment some of the factors considered are crash protective roadside objects, such as barriers and run-off areas.

2.6.3- Post-Crash

The final phase, post-crash, focuses on sustaining life after a crash. Some of the human factors considered are first-aid skills and access to medics. In terms of the vehicle ease of access and the fire risk are considered. Finally, the environmental factors considered are the rescue facilities and traffic congestion.

Subsequently, other systems models have evolved and become widely accepted by governments and institutions. Two of the most influential are those developed by Tingvall (1997) and McAndrews (2013). These systems are similar to the Haddon Matrix, however one of the fundemental differences is that some of the responsibility for road safety is moved away from individals, and placed with governements and institutions. A further significant difference between these system approaches and the Haddon matrix is that the former consider human

fallibility (humans will make mistakes) and points to the need for it to be taken into account in vehicle and road design. Based on these principles, the systems approach suggests road safety is a shared responsibility and a forgiving road system should be built with the knowledge that humans will make mistakes.

It is clear from research therefore that driving behaviour is not a simply product of individual driver predispositions, capabilities and situations. Rather, it can also be crucially by the wider contexts in which driving is undertaken. In particular, there are good grounds to believe that driver behaviour is influenced by strategies and policies developed by governments and other safety-focussed institutions, as well as aspects of wider national cultures, (Australian Transport Council, 2011; Dimmer and parker, 1999). It is also clear that to be effective road safety strategies and policies need, as argued in the United Nation's 'Decade of Action' on road safety that runs over the period 2011-2020, to focus attention on the five pillars of road safety management, safer roads, safer mobilty, safer vehicles, safer road users, and processes of post-crash response (Bibblings, 1997; E.T.S.C., 2012; Toroyan, 2013). Indeed, these pillars have been used by governmental organisations at both the domestic and international levels to set road safety policy. In the case of EU member states, for example, Directive 2010/48/EU lays down requirements for the testing of the roadworthiness of vehicles while recommendation 2010/378/EU harmonises inspection processes among member states by defining what constitute minor, major and dangerous defects. To complicate the picture further, EU vehicle standards are themselves reflective of UN ones (Safetynet, 2009; OECD, 2008). More generally, the following table developed by Tödtling-Schönhofer and Pucher (2010) usefully draws out this point about multi-level institutional levels in relation to the 'key pillars of safety' identified above.

Table 2.2 – Roles of Institutions in relation to driver safety

Type of action	Institutions – geographic/administrative dimension			
	Local	Regional	National	EU
Infrastructure (road design)	E.g. home zones – participatory planning and local acceptance is crucial for speed breakers or cyclist infrastructure	Safe design of intersections for secondary roads (e.g. roundabouts) or Support schemes for local action for black spots	E.g. legislation (norms) for road engineering or road safety audits on highways or Safety in tunnels or Standards for road markings and signs	E.g. similar standards for road safety audits; or Supporting the harmonisation of protection levels, installation and maintenance standards for road restraint systems (safety barriers)
Control and Enforcement	Crucial role of police at local and regional level		Enforcement Standards	Harmonisation of enforcement Standards
Education	Support of RSE for children by local police and municipalities	Regional preventive actions for adolescents with schools	Curricula for RSE in primary and secondary schools	Support to projects and networks on exchange of good practice
Campaigns	Local action days on bike safety	Campaigns in regional/national media (e.g. at start of school season)		Financial incentives for campaigns and support exchange on successful examples
Emergency and post injury services	E.g. voluntary fire brigades organised at local level in many countries	E.g. emergency services organised at regional level	Financing of emergency services through health insurance systems	Setting standards or supporting development of cross-border catchment areas for emergency services
Statistics and data analysis	Collection of accident data	Training of local police officers to safeguard common standards or black spot mapping	Data collection and summary for policy-makers; setting standards	Harmonisation of standards for data collection and interpretation; link to global networks

Tödtling-Schönhofer and Pucher (2010)

With regard to safer vehicles, for example, regulations in some countries stipulate that vehicles must be fitted with certain safety features. For example, European Union (EU) regulation (COM 2008/316) outlines the requirement of a number of new in-vehicle technologies for

specific vehicles. Some of these include advance emergency braking systems and lane departure warning systems for all large vehicles introduced in 2013. Furthermore, the Regulation also foresaw the compliance with the provision of visual and audible seat belt reminders for the driver's in November 2012. This could particularly have help raise the seat belt wearing rates amongst all vehicle occupants (E.T.S.C., 2012)

It is also evident that government policies can influence driving behaviour through the introduction of laws on the use of seat belts, speeding and drink driving. Strong enforcement of such laws is also seen to be of crucial importance in reducing road related deaths and injury (R.S.A., 2007). A study conducted in Ireland for the Irish police force by Siochana (2016) serves to illustrate this point. In Ireland during a five year period between 2008 to 2013 a strong enforcement campaign in relation to drinking and driving was introduced, resulting in a 44% reduction in convictions. However, during the same period there were mixed results in other areas, for example, a 14% increase in speeding fines occured which can possibly be explained by the fact during the same period, speed enforcement was privatised resulting in significantly more speed camera detection.

Tödtling-Schönhofer and Pucher (2010) have also highlighted how through the construction and design of roads governments and other public authorities can also contribute to improved road safety. Many risks can be mitigated by intersection geometry, the design of cycle paths, and road marking and alterations, such as speed humps. In line with this, McAndrews (2013) notes how road design can productively take into account the fact that drivers will make mistakes when designing measures seek to reduce the severity of accidents when they occur. Meanwhile, Tödtling-Schönhofer and Pucher (2010) have noted approvingly the modern trend towards developing self-explaining roads, i.e. roads that in particular promote safe speed of

traffic and support a safe environment for vulnerable road users such as children and elderly pedestrians or cyclists.

Available evidence moreover demonstrates that well thought out government strategies can contribute to significant reductions in road related harm. A case in point is Australia's National Road Safety Strategy 2001–2010. This aimed to reduce the number of road fatalities by 40% to not more than 5.6 in 2010 (A.T.S.B, 2000). Nineteen percent of this was to come from improving the safety of roads, 10% from improved vehicle occupant protection, two percent from new technology aimed at reducing human error, and nine percent from improved road user behaviour (Australian Transport Council, 2001). Evidence suggests that by 2011 Australia had achieved a 34% reduction in traffic fatalities resulting in a 4.92 fatality rate per 100,000 population. The factors that contributed to this reduction were a combination of driver education/ awareness campaigns, stronger enforcement, in particular on drink driving and speeding, as well as improvement in road infrastructure.

Developments in Sweden provide a further illustration of the positive role that can be played by government in shaping road safety. In 1997, the Swedish Parliament adopted a Vision Zero policy, which stated that no one should die or be seriously injured while using the road transport system. It went on to say that the system designers including members of the motor vehicle industry, road traffic planners, road safety engineers, police, health professionals, educators and road users, had a shared responsibility to ensure that the transportation system protects all travellers, even when they make mistakes or are at fault (Tingvall, 1997). While the policy has been criticised on a number of grounds, including in relation to the degree of reliance placed on voluntaristic actions (McAndrews, 2013), it can be noted that Sweden now has the lowest global road fatality rate of 2.8 fatalities per 100,000 population.

Part 2: Work-related driving harm and the employer

This part sets out to explore work-related driving harm. This is done by initially examining the importance of driving for work, along with the scale of work-related driving harm and its causes. Attention is then paid to international recommendations that have been put forward regarding the management of road safety by employing organisations. Finally, existing evidence is reviewed regarding the role of employers in reducing work-related driving harm.

2.7.1- Scale of work-related driving and its harm

It is difficult to measure precisely the amount of work-related driving, not least because of the 'grey fleet' (Helman et al, 2014) of private vehicle drivers who drive as part of their work. Nevertheless, it is clear that work-related driving constitutes a significant proportion of 'all driving'. Indeed, very few organisations can escape exposure to road risks. More than 30% of vehicle registered in Australia are work related ones (Newnam et al, 2014). Similarly, in the UK, 50% of all new cars registered in Britain are company owned, and 10% of all driving is work related (Safetynet, 2009).

The available evidence indicates clearly that not only is work-related driving of considerable importance but that it also accounts for a substantial proportion of driving-related harm. In what follows this point is illustrated by reference to statistics from three developed economies: the UK, Australia and Ireland.

In the UK, according to the Health and Safety Executive (HSE), at least one in three (31%) of fatal crashes and one in four (26%) serious injuries involve someone driving for work (H.S.E., 2014). Department for Transport (DFT) figures for 2016 meanwhile show that 529 people were killed, 5269 seriously injured and almost 40,000 slightly injured in collisions involving a driver

or rider driving for work (DFT, 2017). More widely, Helman et al (2014) have calculated that 62,000 people have been killed or seriously injured and over 500,000 slightly injured in work-related collisions in the UK since 2006. These figures it should be noted exclude deaths and injuries arising while workers are commuting to and from work.

A rather similar picture applies in the case of Australia. According to the Australian Transport Council (2011), work-related road fatalities account for 15% of the national toll, while Newman et al (2014) indicate that such fatalities account for 33% of all occupational deaths in Australia. Within these work-related crashes, reversing incidents have been found to be the most common (Carrs-Q, 2014). Despite road traffic injury being the leading cause of work-related death in Australia, it is still unclear what the true picture is with regard to work- related driving incidents. For example, many people are killed or seriously injured while travelling to and from work in Australia (Australian Transport Council, 2011), only some of which may be recorded as work-related.

In Ireland, according to H.S.A. et al. (2012), around 33% of road collisions involve a vehicle used in connection with work. Furthermore, between 1996 and 2010, it is estimated that 1903 work-related vehicles were involved in fatal collisions, and a further 5845 involved in serious injury collisions. In total, between 2009 and 2015 there was 152 work-related vehicle deaths, accounting for 43% of all workplace fatalities and 15% of the national road death toll (H.S.A., 2016). It should additionally be noted that all of the above mentioned studies and reports suggest that such statistics should be viewed as minimums, and that the real ones are likely to be higher due to underreporting.

The costs associated with work-related driving include, lost work/production time, medical, personal injury, vehicle repair, legal, insurance, reputational damage and environmental costs and are seen as very substantial (Safetynet, 2009). For example, in Britain work-related driving collisions are estimated to cost £2.7 billion annually Dykes (2001), and in the United States of America approximately $56.7 billion in 2017 Motus (2018). In Australia, according to Stewart-Boggle (1999) the estimated cost of work-related collisions in Australia is estimated to be around $AUS425 million each year. The average lost time from road work-related road traffic collisions is greater than from any other work-related injury claim (Safetynet, 2009). Given the scale of the harm associated with work-related driving many countries now consider driving for work it a serious public health problem Helman et al. (2012).

2.7.2- Causes of work-related driving harm

The main causes of work-related fatalities and injury are similar to those discussed previously involving the driver the vehicle and road and weather (see e.g. Clarke et al., 2002; Cuerden et al., 2011; Hamilton and Kennedy, 2005; Bener and Crundall, 2005; Broughton et al., 2010; Kimber, 2005; Lloyd et al., 2013; Mohan et al., 2006; Plankermann, 2013; Shalom and Gitelman, 2014; Treat et al., 1979; R.S.A., 2011; Bambach et al., 2012; Richards et al., 2010; C.O.N.R.O.D., 2011 and Twisk, 1995). However, the available evidence indicates that work-related drivers have a higher collision rate than that of the general driving population, even after considering their higher mileage. Broughton et al. (2003) found car drivers who drove more than 80% of their annual mileage on work-related journeys had 53% more accidents than drivers who drove no work-related mileage. Similarly, Lynn and Lockwood (1998) found that, even after taking higher mileage and demographic variables into account, company car drivers were 49% more likely to be involved in a collision than the general driving population. Some explanations put forward for this include time pressure exposure, fatigue, the reduced personal

costs of accidents (and how this impact driving behaviour) and psychological characteristics, such as aggression and extroversion (Clarke et al, 2005). Further to this Grayson (1999) suggested that journey length, driver condition (fatigue), vehicle condition, lack of training and time of day are some further factors that can lead to driving harm.

More widely, Malka et al. (2018) examined the influence of priorities other than road safety, such as customer service on the incidences of work-related road traffic accidents. The study found those companies with dual-priority led to higher road accident rates compared to those with a single-priority approach based on road safety. These findings in turn can be seen to be echoed in the findings that have been obtained in relation to the contribution that time pressures and fatigue play in explaining the rate of work-related driving accidents.

2.7.2.1- Time pressures

Dimmer and Parker (1999) found time pressure to be the differentiating factor between accident-involved and accident-free drivers they interviewed. More generally, many of the drivers interviewed reported driving under pressure to reach specific destinations on time (Dimmer and Parker, 1999). Meanwhile, in another study drivers admitted frequently performing distracting tasks while driving such as eating, drinking and mobile phone conversations (Broughton et al., 2003). In a similar vein, in a survey undertaken by Adams-Guppy and Guppy (1995), 50% of the 572 drivers sampled admitted often driving at least 10 mph over the speed limit as a result of a desire to be on time for appointments. Further to this Naevestad et al. (2015) while exploring the causes of serious road traffic accidents in Norway triggered by drivers at work, identified that time pressure was a factor, and suggested it was an area that required further research. In the light of such findings Clarke et al. (2005) concluded

that organisational measures are needed to reduce perceived time pressures within business vehicle users.

There is some evidence that such time pressures have increased as a result of many organisations outsourcing their transportation needs, leading to market-based (and competitive) contractor sub-contractor relationships. At a general level, Walters and James (2009) discuss some of the factors that shape the health and safety effects of supply chain relationships, for example the outsourcing objectives of the buyer and the dynamics of the buyer-supplier interactions. In doing so, they note that the buyer can have both a positive or a negative influence on worker health and safety. Meanwhile, Mayhew and Quinlan (2006) conducted a study exploring elements of the Australian long-haul trucking industry. The purpose of the study was to analyse relationships between economic pressure, multi-tiered subcontracting and Occupational Health and Safety (OHS), comparing between owner/drivers and employees (Mayhew and Quinlan, 2006). Differences between owner drivers and employees working for both large and small companies were explored. The findings of the study showed that owner/drivers reported worse OHS than employees working in small and large fleets. The study further reported a connection between economic pressures, supply chain demands and contingent work with negative OHS outcomes. The OHS outcomes resulted from dangerous driving practices such as fatigue, speeding and drug use (Mayhew and Quinlan, 2006). The study supports previous findings of Williamson et al. (2000) and Feyer et al. (2001) suggesting working long driving hours resulted from poor payment incentive schemes, competition and cost pressures on operators. For example, the study found that 68 percent of drivers reported working under a payment by results system, with 17 percent of drivers suggesting they received less than the legal minimum rates of pay (Williamson et al., 2000; Feyer et al., 2001).

More recently Quinlan (2015) discusses the various changes in work arrangements, highlighting that changes have been characterised by less contract duration and job security, more irregular working hours and more sub-contracting. Furthermore, the study suggest that international trade unions have now begun to mount campaigns around the need to regulate supply chains, both in general and in relation to truck driving in particular (Quinlan, 2015).

2.7.2.2- Fatigue

Many of the studies highlight driver fatigue as a risk factor for those driving for work largely due to the nature of the work and the amount of time spent driving (RSA, 2013; HSA, 2014). Clinton et al. (2008) suggests that the nature of the work environment influences the extent of work-related driver fatigue and the risks associated with it. For example, in an Australian study, Arnold and Hartley (2001) discuss the effects managerial practices in the long distance transport industry have on driver fatigue. The study reports that while many transport companies reported they had policies in place that could help manage driver fatigue, very few had formulated fatigue management plans. This would suggest there was little effective practical application of the policies aimed at improving the mangement of fatigue and that responsibility for managing driver fatigue was being placed on the driver. The study identified that the management of driver fatigue was compromised by operational practices, such as penalising drivers for not meeting deadlines and a lack of communication with drivers when they breached the policies (Arnold and Hartley, 2001). It therefore further highlighted that meeting deadlines was a priority, leading at times to drivers working longer hours without breaks, leading to driver fatigue and, ultimately, work-related driving harm.

More recently Retzer et al. (2013) examined some of the causes of work-related driving in the oil and gas industry in the US. The study suggested that the motor vehicle fatality among oil

and gas extraction workers was 8.5 times higher than that of other occupations. Driver fatigue emerged as one of the main factors explaining this, along with speed and loss of control. More specifically, the study's findings indicated that long hours and shift work were acting to place these drivers at an evelvated risk of driver fatigue. A further point raised is that the vehicles used by these workers were light pick-up trucks and therefore ones that were not covered by regulations governing the number of consecutive hours of driving that applied to heavier vehicles.

2.7.3- Recommendations put forward by governments and institution

A variety of domestic and international institutions/governments have produced advice and guidance on the management of work-related driving (I.S.O, 2012; RSA, 2013; HSA, 2014 and HSE, 2014). The central elements of this advice and guidance are broadly similar and exist alongside more issue specific guidance on fatigue.

2.7.3.1- General Guidance

For present purposes attention is focused on International Standards Organisation (ISO) standard 39001 on Road Traffic Safety Management System (RTSMS). This standard was introduced in 2012 and is intended to provide a framework to support continual improvement in road safety within organisations.

The standard helps identify road traffic related risks. The risks are assessed under the categories of the driver, the vehicle, road and the environment. Some examples of those related to the driver include other road users, time pressure, seat belt use, fitness of the driver considering fatigue and distraction and competence and authorisation to drive specific vehicles. Risk factors related to the vehicle include roadworthiness, type, suitability for specific cargo,

occupant at vulnerable road user protection. Finally some risks related to the environment include, traffic and weather conditions, quality and type of road infrastructure, and emergency medical system to name some (I.S.O. 2012).

The standard goes on to offer guidance on appropriate control mechanisms for managing these risks based on a 'hierarchy of controls', the putting in place of mechanisms such as supervision and training aimed at the effective implementation of the identified control measures, and systems for monitoring and reviewing the adequacy of these measures.

With regard to the development and implementation of required preventive measures, the standard emphasises that leadership and commitment are required to ensure resources are available and that an environment is created in which RTS objectives can be achieved. Having considered RTS in context of the organisation, policy needs to be developed to achieve the set objectives, the standard goes on to outline the key roles and responsibilities that need to be defined and communicated.

The final part of the standard provides guidance on monitoring, measurement, analysis and evaluation of the road traffic management system. It outlines what needs to be monitored and measured and when this should be performed. It further suggests methods for monitoring, measuring analysis and evaluation to ensure accurate results. These methods include for example measuring compliance and performance outcomes through key performance indicators. It further outlines guidance on the investigation of road traffic accidents, conducting internal audits and management reviews, and the taking of corrective actions.

The ISO standard can be seen to provide useful recommendations for organisations with regard to the effective implementation and management of work-related road safety. The adoption of

these is, however, voluntary. However, in some countries work-related driving is covered by general workplace health and safety laws. An example of this is the requirement under the UK's Health and Safety at Work Act 1974 that so far as reasonably practicable employers must ensure the health and safety of employees and others who may be affected by the activities of their undertakings. Similarly, in Ireland, the Safety, Health and Welfare at Work Act 2005 is the main piece of legislation that applies to work place safety (R.S.A. and H.S.A. 2009). Currently, work-related driving comes under these laws, making the employer culpable for death or harm caused to an employee while driving for work. It is therefore imperative that the employer understands the risk associated with work-related driving.

To date little research has been undertaken focussed on the uptake of such advice or its impact. However, Naveh and Katz-Navon (2015) conducted a longitudinal before and after study to test an intervention to enhance organisational road safety climate and employee driving, as well as to influence employees behaviour outside organisational boundaries, thereby examining the spill over from the work to the home domain. The intervention was based on the ISO 39001 road traffic management system and consisted of two components. The first comprised developments involving policy, data driven risk analysis, action plans, and manuals, and the subsequent provision of employee safety training and review systems that provided feedback to employees. The second component was the demonstration of enhanced road safety leadership and management commitment. The findings demonstrated that the intervention served to improve the road safety climate, and that this improvement was accompanied by a 75% reduction in safety violations. (Naveh and Katz-Navon, 2015).

2.7.3.2- Driver Fatigue

As mentioned previously, driver fatigue emerges as a considerable risk factor among those driving for work, and has become a topic of discussion in the literature particularly in relation to understanding its occurrence and the countermeasures that can be taken. In general, the guidance given echoes the systematic risk management approach embodied in the RTMS. However, at times this is supplemented by advice shaped around the Haddon matrix. A good example of this is the way in which the guidance offered by Haworth (1998) draws a distinction between the driver, the vehicle and the environment, and advances countermeasures relating to these via three foci: preventing fatigue, preventing crashes and reducing crash severity.

In the prevent phase, it is suggested that education and the limitation of working hours have a significant role to play in relation to drivers, while in terms of the vehicle, the use of the radio, proper ventilation and reduction of vibration and fatigue monitors are identified as the main components that can reduce the risk. Meanwhile, in terms of the environment, rest breaks, pavement treatments (e.g. rumble strips) and wider hard shoulders are identified as important preventive measures (Haworth, 1998).

Haworth (1998) suggests that employers can play a major role in helping combat driving fatigue by educating their employees on the dangers of fatigue. Three different types of educational processes are distinguished. Firstly, the giving of information to help educate the drivers on the dangers of fatigue. Secondly, attempts to change attitudes by convincing drivers that fatigue is an important road safety issue and needs to be taken seriously. Finally, action aimed at changing behaviour by convincing drivers to plan their trips and stop if they are feeling tired.

Balkina et al. (2011) have suggested that there are many strategies available to governments and employers to mitigate the effects of fatigue, most notably the scheduling of work and screening drivers for symptoms of fatigue on a regular basis. More recently, Filtness et al. (2019) found fatigue to be a problem among London bus drivers. The study found the key contributers to driver fatigue included shift work and shift irregularity, sleep quantity and quality, overall health of drivers, stress and mental overload while driving. It further higlighted a lack of policy and regulation relating to driver fatigue. The solutions sugeested included education on the effects and management of fatigue, working conditions, schedules and rosters to consider driver fatigue, open culture to discuss the issue and health screen for drivers (Filtness et al. 2019).

In this section the causes of work-related and non-work related driving harm were reviewed and revealed to be broadly similar. However, the evidence was noted to suggest that those driving for work or company vehicles appear to be at greater risk and are represented in more traffic accidents than those that are not. Time pressures and fatigue have emerged as an important factors in this regard, particularly where transportation has been outsourced and so involves market based and competitive contractor-sub-contractor relationships. Finally, the section has highlighted how governments and institutions globally have provided guidance on managing work-related driving. In particularly, it has been noted that the ISO 39001 standard offers a detailed framework for managing work-related driving. Further to this, it has been argued that employers are well placed to positively influence work-related driving.

2.8- Management of work-related driving risks – evidence on what works

As mentioned above, there are good grounds to argue that employers can play an important role in managing and reducing work-related driving harm. Studies such as T.S.R. (2015) and

more recently Adminate et al. (2017), as well as the ISO standard just discussed, outline how employers can potentially improve work-related driving safety through the adoption of a risk-based, systematic management approach. Others, such as Small et al. (2014) and H.S.A. et al. (2012), similarly suggest that organisations can influence the driving behaviours of their employees by having four key components in place: policies, vehicle standards, journey management and driver safety.

Very little research has been conducted on the dynamics influencing the adoption and implementation of such an approach or on its effectiveness. Instead, most existing research has focused on attempts to influence driver behaviour, either culturally or through more narrowly focused behavioural interventions involving the application of technology. The research in these areas, however, also remains limited and inconclusive. In what follows the evidence emerging from these two rather different strands of research is reviewed. This is done by examining studies that have sought to examine the effectiveness of systematic, organisational-wide initiatives, to improve work-related driving of the type advocated in ISO 39001, secondly reviewing the evidence regarding the links between driving behaviour and organisational safety cultures/climates, and, finally, reporting what research tells us about the efficacy of different types of road safety interventions.

2.8.1- Risk-based systematic management

At present, it would seem that only two in-depth studies of organisational attempts to systematically manage work-related driving risks have been undertaken. Both centred on approaches adopted in relation to company driving fleets (Wallington et al, 2014; Murray et al, 2012).

Wallington et al. (2014) conducted a case study on BT to review and evaluate the outcomes of a driver risk assessment, monitoring and improvement programme in its UK operations. The study was conducted over a ten year period and was based on 95,000 workers and a vehicle fleet of 35,000 vehicles. From a review of BT processes and outcomes, a process was implemented based on health and safety principles, an adapted version of the Haddon Matrix, and government guidance on driving for work that broadly alligns with the prescriptions put forward in ISO 39001. The adopted Haddon Matrix framework included interventions focussed on influencing management culture and leadership, journey management, drivers and vehicles across each of the three crash phases (Wallington et al. 2014). The specific countermeasures adopted included the introduction of policy, management communication and coaching, a driver handbook, consideration of vehicle safety features and processes of work allocation and scheduling. The results obtained suggested that such a comprehensive systems approach could generate extremely positive results. Firstly, the number of vehicle collisions decreased by 40%. Secondly BT saw a 53% reduction in insurance claims over the period of the study. Finally, BT suggest that its annual cost associated with road safety were reduced by 14 million pounds during the programme period.

The second study Murray et al. (2012) was conducted over a five year period on Roche Products Pty Limited of Australia, which is part of a Swiss-based pharmaceutical corporation. The company has two types of work-related drivers, those driving company cars, and those being paid a car allowance to driver their own vehicle on company business. Roche successfully implemented a company motor vehicle safety programme with support from its fleet insurers and risk advisors (Murray et al., 2012). Four key initiatives were put in place as part of this programme. Firstly, a driver risk assessment, monitoring and improvement system. Secondly, a comprehensive company drivers manual was developed that included driving

policies, procedures and processes. Thirdly, process and outcomes were evaluated focusing on overall collisions and comparing risk assessment results against collision histories. Finally, continuous review and refinement of driving policies, procedures and processes was undertaken (Murray et al., 2012). Many of the usual barriers to improving road work-related road safety performance were identified and overcome. The programme led to a range of process and performance-based outcomes. Compliance among drivers taking the risk assessment and getting involved in the driver improvement process achieved 100%. Furthermore, patterns were identified between the results of the driver risk assessments and collision history leading to the enhancement of the driver improvement programme to focus on these areas. In addition, reductions in collision costs as well as overall insurance claims were achieved and sustained. The study therefore highlights that a well-developed work-related road safety programme can result in significant performance improvement within an organisation (Murray et al., 2012).

2.8.2- Role of organisational culture

The terms safety climate and safety culture in relation to organisations are widely discussed in the literature (Guldenmund, 2000; Pidgeon and O'Leary, 2000; Newnam et al., 2008; Newnam and Watson, 2011; Clinton et al., 2008; Warmerdam et al. 2017; Wills et al. 2006; Wishart et al., 2017; Newnam et al., 2017; Pidgeon, 2010 and Rowden et al. 2011). The definitions outlined vary, but are broadly similar. For example, Guldenmund (2000) suggests safety culture could be described as attitudes towards safety, and the underlying beliefs or convictions of the organisation could be describes as safety culture. Pidgeon (2010) suggests a good safety culture requires a number of components. Firstly, senior management's commitment to safety, secondly, a shared concern for hazards and their impact on people, thirdly, realistic and flexible

norms and rules about hazards, and finally continual reflection upon practice through monitoring, analysis and feedback systems.

A range of studies (Heery et al., 2017; Naevestad et al., 2015; Newnam et al., 2008; Newnam and Watson, 2011; Clinton et al., 2008; Newnam et al., 2012; Warmerdam et al. 2017; Wills et al. 2006; Wishart et al., 2017; Newnam et al., 2017; Pidgeon, 2010 and Rowden et al. 2011) have been conducted examining the influence of organisational safety culture on driver behaviour. A common point raised in them is the lack of organisational responsibility. For example, Naevestad et al. (2015) and Warmerdam et al. (2017) have argued on the basis of their findings that there was a culture in the transportation industry where the practical responsibility for road safety was put on the driver rather than including it as part of the overall organisational responsibility. More positively, a number of studies (Newnam et al., 2008; Wills et al., 2006; Wishart et al., 2017 and Newnam et al., 2017) have found correlations between safety culture and road safety outcomes. For example Wishart et al. (2017) found that a strong safety climate weakened the role of thrill and adventure seeking, driving violations, errors and driver fatigue. This further supports the findings of Newnam et al. (2008) which suggested that where supervisors and fleet managers demonstrated positive commitment towards road safety, the drivers were more motivated to drive safely.

Meanwhile, some of the findings of Newnam et al. (2017) also challenge current thinking on the management of work-related road safety. The study found that in conditions of high investment in safety, job design and communications, drivers reported poorer driving behaviour, which contradicts previous research. The study also found that where there was high investment in driver remuneration packages, drivers tended to demonstrated safer driving behaviour. It is important to point out while the investments in remuneration encouraged safer

driver behaviour, it was under conditions of high management commitment to safety (Newnam et al., 2017).

2.8.3- Driver focused initiatives

Only very limited research has been undertaken aimed at evaluating the impact of interventions aimed directly at influencing individual driver behaviour (Grayson and Helman, 2011; Naevestad et al, 2018). That which exists focuses the attention on the impact of driver training, group discussions, technology and incentives. One such study, that by Gregersen et al. (1996) using post-licence drivers of a Swedish telephone company, explored the impact of several of these simultaneously (see further below).

2.8.3.1- Driver training

Grayson and Helman (2011) undertook a systematic review of the literature on the effectiveness of interventions aimed at improving work-related driving safety. The study suggested that there was no evidence that pre-licence training had any measurable effect on reducing accident risk as suggested , and that many of the reports on post-licence training were largely anecdotal (Grayson and Helman, 2011). However, driver training was one of interventions examined by Gregersen et al. (1996) on drivers of the Swedish phone company. Using a control group, accident rates and costs were compared for a two year period before and after the intervention. The one day driver training consisted of three components, low speed manoeuvring, skid training and commentary driving. The main aim of the training was to develop the driver's insight into traffic risks, and limitations of their own ability. The results showed a significant 40% reduction in the collision rate after driver training.

Further to this a longitudinal study using a cross-sectional design by Lynn and Lockwood (1998) found that trained drivers had 8% less accidents than untrained drivers. More recently Bui et al. (2018) conducted a review of interventions and controls used to prevent incidents involving Emergency Service Vehicles (ESV). The study concluded that driver training and risk management may well be effective approaches to mitigating accidents involving ESV. However, the study acknowledged that further studies are required, to identify effective data-supported interventions (Bui et al., 2018).

2.8.3.2- Group discussion

Group discussion was a further element of the study by Gregersen et al. (1996) mentioned above. Gregersen et al. (1996) used the design based on Misumi (1978) where each driver participated in three one hour meetings with groups consisting of 8 to 15 drivers. Problems related to road safety were discussed, along with possible solutions to them. Using a control group, a further 900 drivers partook in this intervention. Similar to above, accident rates and cost were compared for a two year period before and after the intervention. The study found that there was a 56% reduction in collision involvement over a two year period among participants in this particular intervention.

Another Finnish study Salminen (2008) also examined group discussions as an intervention. The study was conducted over a six month period, comparing the number of accidents that occurred in the three years before and after the intervention. The findings showed a 72% reduction in accidents. However, it is important to point out that the change in accidents was based on absolute numbers, which were in fact rather small, 18 before and 5 after the intervention.

2.8.3.3- Technology

Musicant et al. (2007) discusses the change in driver behaviour before and after the use of In Vehicle Monitoring System (IVMS). A footnote below outlines the introduction of IVMS as a road safety tool. The study found that the original data taken from IVMS before the drivers were aware the equipment was recording, correlated with past accident involvement. The study went on to find that the exposure to feedback generated by the equipment resulted in a 40% reduction in crashes. It was also found that the behavioural change that took place remained for nine months after receiving the feedback (Musicant et al., 2007).

A further study conducted by Toledo and Lotan (2006) showed risky driving decreased among drivers after IVMS was fitted. However, the effect on behaviour diminished over time. More recently, Bell et al. (2017) conducted a study, using control and intervention groups, in the oil and gas industry. IVMS was fitted in 315 vehicles, and data was collected over a two year period. One of the intervention groups received feedback through a flashing light in the cab that indicated a harsh vehicle manoeuvre, the other intervention group in addition received feedback and coaching from their supervisor. The control group showed an overall decline in risky driving behaviour during the treatment period. However, the intervention groups showed a more significant reduction in risky driving behaviour, with the intervention group receiving the supervisory coaching and feedback declined significantly more than the group receiving the feedback with just the flashing light.

In Vehicle Monitoring System (IVMS) and road safety.

The past decades have seen great development and use of in vehicle technology most notably In Vehicle Monitoring System (IVMS). Its uses have been to both assist and monitor the driver, presenting both positive and negative effects. IVMS has been used to enhance driver behavioural change with evidence of some success. One application of IVMS discussed in Knipling and Hyten (2015) relates to its use in Behaviour Based Safety (BBS) for truck drivers. Certain barriers arise when applying BBS to commercial truck drivers, mainly due to the fact they are lone workers, working away from their base, making it difficult to observe their behaviour and give feedback. Feedback on performance is a critical factor in (BBS), and is only effective when given frequently. Using IVMS eliminates many of these barriers. For example, drivers can be monitored 100% of the time by IVMS, feedback can be given immediately through audio and visual technology, such as an alarm sound when the driver goes beyond the speed limit or brakes too harshly. Further feedback can be given by supervisors at a later stage and benchmarks set.

2.8.3.4- Incentives

Incentives were a further intervention studied by Gregersen et al. (1996) in the Swedish telephone company study. The incentive scheme chosen was one that included the whole group. A bonus amount for the group was agreed. For each accident caused by a driver of the group the amount was reduced. After one year the remaining amount was given to the drivers in the form of a party, pleasure trip or the buying of an item together, such as fitness equipment. The study found that there was a 23% reduction in accidents among the participants in this group in the two years after the intervention. The authors felt this was a relatively modest reduction compared with the driver training and discussion groups. Some of the possible reasons for the lower performance was that the participants felt the reward levels were too low,

and there was limited interest as the system was seldom discussed. The study suggested that a more attractive bonus system should be developed, which could potentially see great improvements in road safety performance.

A UK study by Lynn and Lockwood (1998) obtained very similar findings, where drivers that were offered rewards had fewer accident than those that had not. However, the study also highlighted that it was possible that the lower accident rate among reward drivers could be associated with other non-financial factors such as being recognised as a 'good driver' (Lynn and Lockwood, 1998). Several further studies focused on driver incentives are reported in the now rather dated proceedings of an international road safety symposium held in Copenhagen, Denmark (Koornstra and Christensen, 1990). For example, Walter Schneider discusses a long-term driver incentive scheme by German company Kraft. The results showed a reduction in accidents from 2.02 to 0.25 per 100,000 km over a 30 year period. In addition, the cost per accident reduced by approximately 83% during the same period. It was further suggested such incentives is also a means of creating or reinforcing motives for avoiding risk on the part of the drivers. It was further suggested that by influencing individual safety this can then enhance group safety values and norms (Koornstra and Christensen, 1990). Meanwhile, in another study Wiel Janssen discussed the results of a study using an approach in the line of classical utility theory that presented some tentative and testable guidelines when choosing a particular incentive scheme for drivers. For example, the findings showed that proportional schemes tend to yield better results than corresponding all-or nothing schemes. They further revealed that group incentive schemes acted to change behaviour more than individual based ones. More generally, the study found there are many successful ways to develop driver incentives but that the degree of their success is determined to a large extent by how they are designed and administered. (Koornstra and Christensen, 1990).

2.8.3.5- Supervisory leadership

Other studies discuss interventions to improve road safety focused on the leadership of management and supervisors. For example, Newnam and Oxley (2016) discuss interventions aim at developing supervisors skills to identify situations where drivers are at risk and then effectively managing them through a programme referred to as Safety Management for the Occupational Driver (SMOD). The findings of the study indicated that the programme led to improvements in supervisory road safety motivation, leadership, attention and awareness (Newnam and Oxley, 2016). Another study by Newnam et al. (2012) found a significant relationship between safety information exchange and the quality of leader-staff exchanges and that this in turn positively affected driving performance (Newnam et al., 2012).

2.8.3.6- Summary

In this section we discussed work-related driving and the role of the employer in this. The available evidence indicates clearly that not only is work-related driving of considerable importance, but it also accounts for a considerable portion of driving related harm globally. The causes of work- and non-work-related driving harm are similar however, some of the influencing factors differ. Time pressure remains a significant factor, particularly in relation to drivers in outsourced employment arrangements, which in turn lead to driver fatigue. The evidence also indicates that those engaged in work-related driving are represented in higher numbers of road traffic accidents. Governments and institutions have offered guidance and recommendations on managing work-related driving, an example being the ISO 39001 RTMS. Such guidance extols the virtues of employers adopting a risk based systematic approach towards the management of work-related driving. With the exception of a couple of studies, little research has, however, taken place on the dynamics influencing the approach or its effectiveness. Further evidence indicates that organisational culture can influence work-related

driving, both positively and negatively. Finally, there is some limited evidence to suggest that certain interventions, such as driver training, group discussions, technology and supervisory leadership, can positively influence work-related driving.

Part 3: Occupational health and safety mananegement

In contrast to work-related road safety, occupational health and safety (OHS) management has been the subject of extensive research (see e.g. (Frick, et al., 2007; Hopkins, 2006; James, et al., 2007; Robens, 1972; Robson, et al., 2007; Quinlan, et al., 2001; Quinlan, 2015; Turner, 1994; Walters, 2002; Brooks, 2001). The resultant literature provides potentially important insights into the management of work-related driving risks for two reasons. First, it can be argued that the management of such risks logically forms part of OHS management; albeit an aspect of it which rarely receives systematic attention. Secondly, the prescriptions advanced regarding the management of OHS, as shall be seen, broadly echo those advanced in relation to work-related driving.

This section consequently focuses some relatively brief attention on the literature on OHS. It begins by drawing out the parallels that exist in the prescriptions that are put forward in relation to its systematic management. It then moves on to highlight a number of key factors that have been found to support, or undermine, such management.

2.9- Nature of systematic OHS management

Understandings of how harm arising from work activities can best be prevented have changed over the years. This can be usefully demonstrated by reference to the changing nature of the legal requirements placed on employers across the developed world and, more particularly, in Britain.

The first factory legislation was adopted in Britain in 1802 in the form of the Moral of Apprentices Act. From this humble beginning, a complex body of statutory law developed over the next seven decades. In 1970 a committee on safety and health at work was established. Chaired by Lord Robens, this committee reported in 1972 and central to its recommendations was that the nature of the then prevailing system of statutory law should be reformed to place much less reliance on prescriptive command and control requirements and instead place primary reliance on goal orientated duties that sought to encourage a greater degree of self-regulation on the part of employers and working people (Robens, 1972).

Domestically, the recommendations of the Robens Committee were subsequently substantially enacted in the Health and Safety at Work Act 1974. More widely, its philosophy of self-regulation influenced legislative reforms across much of the developed world (Bennett, 2002; ILO, 2001). In particular, it prompted the widespread adoption of legislative provisions that detailed the management processes that employers needed to put in place to secure the protection of workers and engender the adoption of a reflective self-regulatory approach to the control of workplace risks (Aalders and Wilthagan, 1997). The EU framework directive (1989/391/EEC) that was adopted in 1989 serves to further illustrate this change, as well as the more specific types of requirements imposed on employers (Walters, 2002; Brooks, 2001). Thus, it required member states to have in place systems of OHS regulation that, among other things, imposed obligations on employers regarding:

- Carrying out risk assessments
- Putting in place of measures to remove (or, failing that, control) any unacceptable risks
- Establishing systems of management to ensure compliance with these measures
- Providing relevant training and information to workers
- Consulting workers and their representatives over the above issues

- Keeping the measures undertaken under review and amending them where the need to do so becomes apparent.

A variety of non-legal standards, guidelines and audits have been developed that serve to spell out in more detail the elements of such a systematic approach to the management of workplace health and safety (BSi, 1996; BSi, 1999; Dalrymple, et al., 1998; Frick, et al., 2007; Gallagher, et al., 2001; ILO, 2001). One of the most influential is ISO 45001. As will be seen, its prescriptions very much echo those found in the previously discussed ISO 39001 standard relating to the systematic management of work-related road safety. For this reason, the requirements of this standard are briefly reviewed as it serves to simultaneously highlight not only widely accepted notions of what constitutes effective OHS management but how these essentially mirror those promulgated within the field of work-related road safety.

The ISO 45001 standard was adopted in 2018 and incorporates elements of OSHA 18001 and ILO guidelines while also adding to them. It follows a similar format to the previously discussed 1SO 39001 RTSMS and is based on the concept Plan-Do-Check-Act (PDCA) (ISO, 2018). More specifically, the standard breaks the process of managing OHS into five main stages or elements: planning to determine and assess the risks and opportunities for improvement; establishment of objectives and processes to deliver results in accordance with the company's policy; implementation of the laid down processes; checking and monitoring these processes and reporting results; and, finally, action to continuously improve OHS performance to achieve the intended outcomes.

The standard states that determining risks and opportunities is an ongoing process that incorporates anticipating changing circumstances. Hazard identification is seen to begin at the conceptual design stage and involve considering routine and non-routine activities and situations, as well as human factors, and putting controls in place to eliminate or reduce the

risk. The standard identifies that opportunities to improve OHS can be gained through such means as audit and inspection, job hazard analysis, and incident investigation Other opportunities may, it notes, come from legal requirements, such as legislation, treaties, collective bargaining agreements and other contractual employment conditions, codes of practice, and technical specifications (ISO, 2018).

According to ISO 45001, organisations should establish enough processes to have confidence that risks are controlled, and they are sufficient to achieve the intended outcomes of the OHSMS. Furthermore, the standard states that the requirements of the OHSMS should be incorporated into the various business processes, for example procurement, human resources, sales and marketing. The importance of leadership and commitment from the organisation's top management is also stressed since they determine the OHS policy of the organisation and the relevant roles, responsibilities and authorities, and ensure relevant resources - human, infrastructure, technology and financial - are available. The importance of consultation and participation with workers in these processes is also stressed.

The performance of an OHSMS should, according to the standard, be evaluated through monitoring, measuring and analysis. Examples of monitoring provided include the investigation of occupational health complaints and work-related incidents, health surveillance, monitoring of the work environment, and the compilation and examination of statistics on injuries and ill health. Further examples suggested included the fulfilment of legal and other requirements, such as those laid down in collective agreements and by insuring organisations. Analysis according to the standard is the process of examining such data to reveal relationships patterns and trends which can be compared with other similar organisations to draw conclusions about the adequacy of performance (ISO, 2018).

The standard suggests other critical success factors that need to be considered should include, an assurance that the level of competence that the workers hold, is appropriate to identify and manage hazards associated with work and the workplace. Awareness and communication of OHS risk to all workers and interested parties, as well as temporary workers, contractors and visitors is a further critical factor. According to the standard, documentation complexity should be kept to a minimum level to ensure effectiveness, efficiency and simplicity. Further risks that need to be considered relate to outsourcing and the use of contractors, which can be managed by verifying contractors OHS performance is satisfactory, their workers are qualified and competent and resources, equipment and work preparations are adequate before they start any work (ISO, 2018).

The final part of the PDCA concept is focused on acting to maintain continual improvement. Improvement, it is stated, in general can result from corrective action, innovation and re-organisation. Continual improvement is seen to potentially arise from a variety of sources, including new technology, promulgated good practices, the above processes of monitoring, and suggestions and recommendations from interested parties.

The PDCA approach in ISO 45001 is clearly echoed in the previously mentioned Road Traffic Safety (RTS) standard. In the ‘planning’ part of the RTS, for example, it is also stressed that leadership is required to support the adoption of a long-term vision to eliminate road related death and injury paralleling that of the OHSMS. In the ‘do’ part, it similarly details a host of requirements relating to the implementation and operation of the RTSMS and ensuring it has the capacity to achieve laid down objectives and targets. Meanwhile, like ISO 45001, the ‘checking’ part of the RTS requires the monitoring and evaluation of performance through audits and reviews to ensure continual improvement, while the final ‘act’ part, stresses the

importance of acting on nonconformities and deficiencies with corrective actions aimed at reducing unacceptable risks of death and injury.

2,9.1- Factors influencing OHS management effectiveness

There is a good deal of evidence that such a systematic approach to OHS management can be highly effective (Saksvik & Quinlan, 2003; Brooks, 2001; Gallagher, 1997; Gallagher, et al., 2001; Frick, et al., 2007). Gallagher et al. (2001), for example, argues that an OHSMS can achieve better OHS outcomes and deliver a healthy and safe workplace under the right circumstances. At the same time, the evidence suggests that this outcome is a conditional one that is dependent on the presence or absence of a number of factors that can support, or undermine, its operation. Indeed, this point is effectively reiterated throughout the ISO 45001 text, via the prescriptions it advances and the guidance it provides in terms of adopting them in a way that takes due account of a range of internal and external organisational factors. Such external factors are noted to include the surrounding cultural, social, and political environment, the nature of market competition, the nature of contractors and sub-contractors, and the expectations of trade unions, clients, customers and the local community. Meanwhile, internal factors identified include, organisational structures, policies, roles and responsibilities, relationships with workers, and prevailing work processes and conditions (ISO, 2018).

Research furthermore highlights that, notwithstanding their apparent comprehensiveness, OHMSs can go wrong and fail in the objective of protecting those they are intended to protect. Quinlan, for example, has identified what he terms ten pathways to disaster based on a review of investigations into 24 fatal incidents and disasters in the mining industry across five countries (Quinlan, 2014). These encompass design, engineering and maintenance flaws, failures to heed clear warning signals, flaws in risk assessments, flaws in management systems, flaws in systems of auditing, economic/reward pressures compromising safety, failures in

regulatory oversight, the ignoring of worker, consultant and supervisor prior concerns, poor management-worker communication/trust and flaws in emergency procedures/ resources. The role of such factors in undermining the effectiveness of health and safety management systems have moreover been highlighted in a wide range of other studies (see further below).

Echoing to some extent the above analysis of Quinlan, research has long pointed to the tensions that can exist between the requirements of good health and safety management and the financial priorities and motivations of employing organisations which can act to restrict the willingness of employers to invest in the protection of workers (Dawson et al, 1998; Nichols, 1997). More recently, it has highlighted how two major changes in the world of work over the past few decades – the decline in worker voice and the increased fragmentation of organisational structures and employment (Benassi & Dorigatti, 2015) – have served to increase the influence of such potentially damaging tensions, as well as the adverse implications flowing from them.

In the first of these areas, such tensions have not only been highlighted by Quinlan's analysis of disasters but also studies, including those of official inquiries, focussed on particular ones (Department of Energy, 1990; Department of Transport, 1989; Woolfson, et al., 1996; Hopkins, 2011). More narrowly, there is a long history of studies revealing how production pressures and incentives, including ones built into frontline payment systems, can lead to accidents as a result of workers being incentivised to take shortcuts. This results in workers making errors as a result of long working hours and/or high intensity working and/or being encouraged to violate laid down rules and procedures by supervisors and managers (Nichols & Armstrong, 1973; Nichols, 1997; Grunberg, 1986; Wrench & Lee, 1982; Reason, 1990; Reason, 2013). Furthermore, Frick (1990) has valuably highlighted how OHS can be managerially marginalised and rendered a 'side car' issue by a failure to integrate it into the main business

systems and processes of organisations, while analysis has cast considerable doubt on the validity of official arguments that investment in health and safety necessarily makes economic sense from the point of view of commercial enterprises (Cutler & James, 1996; Nichols & Walters, 2013). In a similar vein, evidence indicates that organisational willingness to comply with legal requirements is strongly influenced by the likelihood of cases of non-compliance being identified and penalised by regulatory agencies (Short & Toffel, 2010).

Recent trends in worker voice have acted to reduce the capacity of workers to act to counter the potential adverse implications flowing from such tensions. Meanwhile, the adoption of more fragmented organisational structures and employment arrangements have served to compound them.

2.10- Decline in worker voice

It is generally agreed that in order for an OHSMS to be successful a number of critical components are required, such as commitment from senior management, extensive employee influence and participation, integration of the OHSMS with the general management system and practices, and a focus on controlling hazards preferably at the upstream design stage rather than by trying to control worker behaviour (Frick, 2011; Madsen, et al., 2020; Gallagher, 1997; Frick, et al., 2007).

Evidence shows worker representation (and voice) to be positively associated with safety performance (Nichols & Walters, 2013; Robinson & Smallman, 2013; Frick, 2011; Walters & Nichols, 2007). It is argued that this connection between worker representation and positive OHS performance reflects several different benefits of such representation. First, by having a continuous presence on the frontline, workers develop an understanding of day-to-day work processes and the OHS problems associated with them that need to be addressed. Secondly, workers and their representatives, because of this knowledge, can be in a position to identify

satisfactory solutions to these problems. Thirdly, acting collectively, workers can have a capacity to apply countervailing pressures and in this way challenge managerial priorities and objectives serving to undermine the effective control of risks.

The recent decades have, however, seen a decline in the collective representation of workers both generally and more specifically in relation to OHS (Benassi & Dorigatti, 2015; Wilkinson, et al., 2010). In particular, union membership has declined significantly across the developed world, along with union-based workplace representation (Visser, 2019). For example, union density rates have seen the greatest decline in developed and lower-middle-income countries. Unions in the developed countries lost 14 million members between 2000 and 2008. The share of union membership in developed countries has fallen to 50% of the world's total in 2017, down from 57% in 2000 (Visser, 2019).

This decline has coincided with a rise in prominence of health and safety management systems that, in contrast to the approach advocated in ISO 45001 and ILO guidelines, marginalise or at least place much less emphasis on representative worker voice. In exploring the use of behavioural based OHS systems in the global container industry, Walters and Wadsworth (2016), for example, found that safety performance was poorest in terminals where systems of collective worker representation were absent or least developed, and management's approach was most strongly behavioural in orientation. In contrast, where such systems remained strongly in place, performance was found to be better.

2.10.1- Organisational and employment fragmentation

In recent decades organisations, as a response to increased, competition, both domestically and globally, have sought to reduce costs by placing greater reliance on atypical forms of employment, such as casual, agency, temporary and zero hours personnel, and sub-contracting

the provision of goods and services to external contracting organisations (Standing, 2011; Walters & James, 2020; Walters & James, 2009). In many cases, this last change has in turn been associated with sub-contracting organisations themselves contracting out work, with this process therefore leading to the creation of multi-tiered contracting arrangements.

There is growing recognition that both of these trends, as well as the labour shedding of directly employed staff associated with them, may have negative consequences for OHS (Frick, et al., 2007). For example, research indicates that labour shedding and outsourcing can adversely affect the OHS of remaining staff in a number of ways, such as through increases in workload and pressure, deteriorations in work/ life balance, and heightened job insecurity (Houben & Nijihuis, 1996; Simpson, 1997; McCarthy, et al., 1995). Meanwhile, the evidence highlights how those labouring under atypical, or non-standard, work arrangements often experience less favourable OHS experiences and outcomes. Drawing on fragmented research, Frick et al (2007), for example, have highlighted that part-time/casual workers are less likely to receive OHS training and will often lack relevant job knowledge and experience, as well as knowledge about how to safeguard their own safety. In a similar vein, reviews of the evidence (Quinlan, et al., 2001; Quinlan & Bohle, 2008; Bohle, et al., 2004) have revealed similar disadvantages of casual/outsourced employment. Bohle et al. (2004) identified that casual workers doing the same job as permanent workers have less desirable and predictable work schedules, greater work-life conflict and more associated health complaints. Similarly, Quinlan and Bohle (2008) found that 92% of international studies focusing on the OHS effects of sub-contract and home-based workers had obtained findings pointing to poorer OHS outcomes. More specifically, in terms of the health effects of casual or flexible working, Benach et al. (2002) report the associated job insecurity to be associated with psychological ill health and higher morbidity

rates, and similar findings have emerged from the European Work and Conditions survey (Eurofound, 2019).

The growth that has taken place in such forms of employment, and the adverse OHS effects associated with them, have been found to be intimately connected to the trend towards externalisation already mentioned (James & Lloyd, 2008). The same is true of two other significant labour market changes, namely a reduction in employment in large organisations alongside a corresponding growth in small and medium sized companies: shifts that have meant that work has often moved from large well-resourced organisations to smaller much less resourced ones. That is ones that are less in a position, both in knowledge and resource terms, to manage OHS risks effectively (James, et al., 2007; Walters & Wadsworth, 2016; Quinlan, 1999; Quinlan & Bohle, 2009; Frick, et al., 2007)

More widely, there is a good deal of evidence indicating that the dynamics within the inter-organisation supply relationships embedded in supply chains can, for a number of reasons, generate adverse health and safety outcomes (Walters & James, 2009; Walters, et al., 2012). Studies in construction, for example, have revealed that in situations of on-site sub-contracting those working for sub-contractors can receive less training and lower levels of supervision, inter-organisational communication problems can occur and the co-ordination of health and safety management across the site can become problematic (Johnstone, et al., 2005; Rebitzer, 1995; Quinlan, 2015; Kochan, et al., 1994; Quinlan & Bohle, 2008). It is also apparent that powerful buyers at the top of supply chains can have a capacity to impose demanding cost and delivery demands on suppliers lower down them that in turn place them under pressure to increase work intensity and cut costs by reducing investments in OHS and reducing compliance with relevant legal duties (Walters & James, 2020).

Such findings are potentially highly relevant to the road transport sector since, as was noted earlier in this chapter, it is one in which high levels of sub-contracting can be found (Williamson et al., 2000; Feyer et al., 2001; Mayhew and Quinlan, 2006; Quinlan, 2015). More specifically, a number of studies have shown how the safety (and health) of sub-contracted truck drivers can be endangered as a result of competitively generated time and economic pressures, irregular working hours and the incentive payment systems they work under (Quinlan, 2001; Belzer, 2000). For example, in a recent study (Rawling, et al., 2017) found that those at the top of the supply chain held tremendous influence which they used to place more reliance on trip based and incentive-based payment arrangements that resulted in lower pay for drivers. This in turn was found to have led drivers to engage in hazardous driving practices, such as speeding and driving while fatigued, that resulted in poorer safety outcomes.

In summary, this section has highlighted the parallels that exist between the prescriptions advanced with regard to the management OHS, on the one hand, and work-related road safety, on the other. It has further been argued that the management of work-related road risks logically forms part of OHS management; albeit an aspect of it which rarely receives systematic attention. More particularly, OHMSs of the type advocated in relation to work-related road safety have been shown to be potentially effective. However, it has also been noted that a variety of factors can undermine this effectiveness. Such external factors have been noted to include the surrounding cultural, social, and political environment, the nature of market competition and contractor/ sub-contractor relations. Meanwhile, internal factors identified include, organisational structures, policies, roles and responsibilities, relationships with workers, and prevailing work processes and conditions (ISO, 2018). Finally, the section has drawn attention to the effectiveness of OHMSs but also how this can be undermined by a trend towards the externalisation of work.

2.11- Conclusion

Part 1 of the chapter focused on the extent of driving harm, and the the causes and prevention of it. In relation to the first of these issues, the evidence reviewed highlighted the massive scale of death and injury flowing from road traffic accidents. Road traffic accidents have been shown to be the eighth leading cause of death, killing 1.24 million people annually, to result in injuries to a further 20 to 50 million people (Toroyan, 2013). Deaths related to road injury therefore account for 2.2 percent of deaths globally, and exceed those from many other causes, such as hypertensive (heart attacks associated with high blood pressure), preterm birth, tuberculosis and some forms of cancer (WHO, 2014).

The evidence suggests that road traffic accidents are multi-causational made up of the road user, the vehicle and the environment. By examining the causes of traffic accidents in different regions it emerges the causes are the same globally. The studies also show similar patterns concerning the relative importance of these categories of causal factors. Research further points to a number of individual driver characteristics that are associated with the propensity to experience traffic accidents. These characteristics include various aspects of attitudes, and the roles played by culture, speeding, distraction, anti-social motivation, and a lack of training and education and time pressures.

There is widespread agreement in the literature that a systems approach needs to be adopted in order to understand the causes of road accidents and the harm they cause, and the remedial actions required to improve the stituation (McAndrews, 2013). More specifically, it is generally acknowledged that action to reduce the number of road traffic accident and the scale of harm flowing from them needs to focus attention on five road safety ‘pillars’: safe speed, safe roads,

safe vehicles, safe people and post crash care. There is furthermore clear evidence that governments can take effective action in each of these area to and thereby improve road safety performance. For example, governments can set safe speeds to reduce the potential for accidents, and reduce the impact when they do occur. Furthermore improved emergency response times and post crash care can postively influence the outcomes of road traffic accidents. Meanwhile, improvements can also be secured through the appropriate construction and design of roads. Thus, many risks can be mitigated by intersection geometry, and the design of cycle and footpaths that keep vulenerable road users seperated from live traffic as much as possible, and education and enforcement can be undertaken to improve driving behaviour (R.S.A, 2007).

Part 2 focused on exploring work-related driving harm and the role the employer plays in this. This was done by initially examining the importance of driving for work, along with the scale of work-related driving harm and its causes. Attention was then paid to international recommendations that have been put forward regarding the management of road safety by employing organisations. Finally, existing evidence was reviewed regarding the role that employers can play in reducing work-related driving harm.

The view that employers can act to improve road safety was noted to come from two separate arguments. Firstly, employers are well placed to influence behaviours that the general literature indicates leads to a high proportion of road incidents. Secondly, employer action can also influence the time pressures and other factors that have been found to be of particular importance to work-related accidents, and which can only be dealt with by action at the level of individual employing organisations.

Work-related driving was found to constitute a substantial proportion of 'all driving' and to be responsible for a significant proportion of road deaths and injuries. Evidence indicates that those engaged in work-related driving are more prone to experience road accidents and injuries, even after taking higher mileage and demographic variables into account (Lynn and Lockwood, 1998). The greater propensity for drivers engaged in work-related driving to experience accidents seems to reflect a variety of factors that encourage risk taking (H.S.A. et al, 2012), as well as time pressures (Clarke et al, 2005) and fatigue (H.S.A, 2014).

Internationally various organisations have published advice on the management road safety risks, most notably ISO. This advice exists alongside other guidance focused on the management of fatigue. These sources of guidance exhibit a good deal of similarity in terms of detailing a risk management framework embodying processes of risk assessment, the adoption of risk management strategies based on a 'hierarchy of controls', the putting in place of mechanisms (like supervision and training) aimed at the effective implementation of the identified control measures, and systems for monitoring and reviewing the adequacy of these measures as well as their implementation.

To date little research has been undertaken focusing on the uptake or impact of the guidance mentioned above or of the systematic approach to risk management that it advocates. Although, that which has been undertaken lends some support to the value of the approach (Naveh and Katz-Navon, 2015; Wallington et al, 2014; Murray et al, 2012). In a similar vein, only limited research has been undertaken to evaluate the value of individual types of intervention, such as driver training, group discussion, technology and incentive schemes (see e.g. Gregersen et al., 1996; Grayson and Helman, 2011; Naevestad et al, 2018).

The chapter has therefore confirmed that a relatively sparse literature exists on the dynamics surrounding work-based driver behaviour and its effective management. As a result, the existing literature provides limited insight into to the potential of employers to improve work-related driving safety, the factors that can contribute to a positive influence, and the barriers and challenges that can hinder employers influence. At the same time, attention has been drawn to how prescriptions in the wider OHS literature echo those put forward with regard to the management of work-related driving and in doing so further highlights a number of factors that have been found to influence, both positively and negatively, their operationalisation.

Overall, the chapter has revealed that the current literature relating to both the capacity of employers to act to improve road safety and the factors that influencing it remains very limited. It is consequently argued to both justify the decision to undertake the present study and to highlight its potential to make a meaningful contribution to existing knowledge regarding the management of road safety by employers. Meanwhile, the OHS literature reviewed is seen to have valuably drawn attention to some of the factors that can be anticipated to influence the effectiveness of employer attempts to reduce the risks and harm associated with work-related driving.

Chapter 3: Methodology

3.1- Introduction

This chapter details the methodological choices that have shaped the empirical components of the study and the way in which they have been operationalised. It does so in the context of the study's aim, namely to undertake case study research to shed new light on the role that employers can play in reducing work-related driving harm. To support the achievement of this aim, the following objectives have been developed.

- the carrying out of a literature review encompassing the factors that influence road safety, both generally and in the work context, the potential role of employers in improving work-related driving, and the potential insights that can be gained into this role through findings contained in the literature on occupational health and safety management;
- the undertaking of new empirical research focussed on the management of work-related safety, and, more particularly, its capacity to generate safety improvements and the factors that influence this capacity, through the aforementioned case study
- the drawing out of lessons from these conceptual and empirical strands of the research for current knowledge and future research regarding employer management of work-related driving..

The chapter is divided into three main sections. The first focuses on explaining and justifying the decisions made with regard to the adoption of an inductive, interpretivist approach to the study, the choice of a single case study research design, and the data collection and analysis methods employed. Part 2 then moves on to detail how these methodological choices have been

operationalised. Finally, the third section addresses the issue of study's compliance with good ethical standards.

3.2- Methodological choices

3.2.1- Inductive, interpretivist approach

The decision to adopt this approach reflected two sets of considerations. The first was the considered inappropriateness of a deductive positivist approach to the study's aims and objectives. The second was the perceived virtues of an inductive, interpretivist one in this regard.

The positivist world view, in contrast to the interpretivist , is informed by a belief that there is an objective reality that can be perceived and tends to be operationalised via the specification and testing of hypotheses (Williamson, 2006). Key positivist tenets are therefore "measurement" and "objectivity," resulting in a focus on quantitative data. A deductive approach is in turn supported by a 'Positivist' stance which is based on observable experience rather than intuition (Williamson, 2006). The common research methods associated with positivism are therefore experiments and surveys that focus on cause and effect relationships and are carried out according to scientific principles (Williamson, 2006). Validity and reliability are, Williamson (2006) observes, consequently key constructs within the positivist approach since findings are intended to be generalisable and able to be replicated on different populations.

As shall be seen, part of the present research will involve the analysis of secondary statistical data. This analysis, although of a quantitative nature, will, however, be descriptive in nature. It

will not therefore involve the generation and testing of hypotheses. More widely, the study's central empirical objectives – examining how the PDO had strategically sought to achieve high road safety standards and with what effect and for what reasons – do not lend themselves solely to quantitative analysis since they necessarily involve processes of subjective interpretation and opinion, and hence conflicts of evidence that do not accord with the standardisation of measurement required within positivist approaches.

Reflecting critically on the study's aims and objectives it became clear that a more inductive approach would enable a deeper understanding of many of the issues central to them. Myers (2008), for example, notes that interpretivism integrates human interest into a study, and assumes access to reality is through social constructs, such as language, consciousness, shared meanings and instruments. Williamson (2006) meanwhile views interpretivism as a broad term that encompasses a number of different paradigms, all concerned with the meanings and experiences of human beings. Furthermore, other relevant virtues of an inductive approach are that it can be used to study a limited number of cases in detail, does not require the *a priori* generation of hypotheses and can support an interactive process of data collection and exploration that can help understand an experience as it is 'lived' 'felt' or 'undergone'.

3.2.2- Single case study design

While there are many definitions of a case study, they generally exhibit a good deal of commonality. Thus, Yin (2003) describes a case study as a "*empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (pp13)*, while Zainal (2007) describes it as a method that allows a researcher to closely examine data within a specific context such as small geographical area or a limited number of individuals. A case study can

thus be summarised as an empirical in-depth study about a group, organisation, event, family individual or a place, usually asking ‘how’ and ‘why’ questions (Stake, 1995; Simons, 1980).

Many categories of case study are discussed in the literature. For example, Yin (2003) notes that case studies can be exploratory, descriptive and explanatory. He further argues that three conditions should be met before choosing a case study design that relate to the type of research questions posed, the extent of control the researcher has over actual behavioural events, and finally the degree of focus on contemporary issues. Each of these conditions it is argued are met in the current case. Thus, the research objectives encompass ‘how’ and ‘why’ questions, the researcher has no control over the behavioural events being studied, limiting the possibility of manipulation, and the issues being investigated are contemporary in relation to road safety.

Further virtues of case study research are that it can explain casual links in real life interventions that are too complex for either surveys or experiments, and has an ability to accommodate multiple sources of data collection. Such research can consequently enable the triangulation of data from different sources (Yin, 2003). In this way, it can overcome the potential problems of bias and validity associated with inductive, interpretivist research.

The literature distinguishes between single and multiple case study designs, each of which are seen to have their own merits. Multiple case studies, for example, can support analytic or theoretical generalisation (Robson, 2011) and, according to, be linked together to reveal similar patterns, thereby increasing the robustness of the findings and their generalisation.

Nevertheless, it is recognised that single case studies can be of value in certain circumstances, notably where they focus attention on unique situations and/or seem likely to generate insights

that could valuably inform future research. The present study is argued to be a case in point. Relatively few in-depth studies exist of the operation of corporate road safety strategies and policies. The relevance of current research findings to both the causes and prevention of road accidents in such situations consequently remains unclear. Furthermore, given Shell's international reputation regarding road safety (Bekefi, 2006), a study focussed on PDO would appear to potentially generate important new insights in both of these areas and in doing so make a useful contribution to the existing research literature.

3.2.3- Types of data collection

Silverman (2004) and Cassell and Symon (2004) note that there are many qualitative research designs. Some of the data collection methods available include, interviews, questionnaires, surveys, observation, documents, focus groups and secondary data analysis. Each of these methods has its own merits and uses depending on the research questions. They were therefore evaluated in the context of the aims and objectives of this study, and the data required to achieve these. Taking into account the adopted interpretivist position and inductive approach, it was decided that the most suitable methods for this particular study would be a mixture of semi-structured interviews, descriptive statistical analysis and focus groups. The principle of triangulation influenced this selection of data collection methods given how, as already noted, the use of multiple sources of data (Yin, 2003) can overcome potential problems of bias and validity in qualitative research (Scandura and Williams, 2000; Blaikie, 2000).

3.2.3.1- Interviews

Silverman (2004) distinguishes between three main types of interview - structured, semi-structured and unstructured. Each, it is argued, can produce rich data depending on the context within which they are being used.

Semi-structured interviews sit in between structured and unstructured ones and are sometimes referred to as a conversation with a purpose (Silverman, 2004). Semi-structured interviews are qualitative and exploratory in nature, lending themselves to an interpretivist position. The interviewer guides the questions and is clear on the areas that need to be covered but allows interviewees to respond in different ways and the relevant issues to be addressed flexibly, in terms of the order with which they are discussed and how they are raised. As a result, semi-structured interviews provide a balance between flexibility and control. Semi-structured interviews use mostly open-ended questions as well as probes and prompts to explore the thoughts of the interviewee.

Such interviews appeared most suitable for the present study given its aims and objectives. On the one hand, they were seen to potentially facilitate valuable self-reflection on the part of interviewees and to give them an opportunity to raise issues that they considered to be of importance. On the other, they would ensure that all the issues deemed of initial relevance were covered and, in this way, provide a good basis for drawing comparisons between different responses.

3.2.3.2- Focus Groups

Focus groups have their origin in sociology and it is widely suggested in the literature that the pioneers of the focus group interviews were Paul Lazarsfeld and Robert Merton in the 1940s (Morgan, 1988). According to Merton et al. (1956), focus group interviews should be conducted with individuals who have a shared experience. Focus groups can therefore be described as a type of in-depth group-based interview in which participants with shared experiences can influence each other through their answers, ideas and contributions to a discussion that is stimulated by a moderator (Morgan, 1988). The comparisons that emerge

from such discussions with regard to participants experiences and opinions can provide a valuable source of insight into their behaviours and motivations (Kruger, 1994).

Krueger (1994) notes that there are both advantages and disadvantages to using focus groups. Compared to individual interviews, the researcher can have less control of the data collected. It can also be difficult to assemble appropriate groups and those conducting them need to be trained. However, on the other hand they are relatively easy to conduct, allow for topics to be explored in some depth, thereby facilitating the generation of hypotheses, and can produce findings quickly and generate data that have high face validity. Furthermore, Morgan (1988) discusses how researchers can use focus groups to supplement both quantitative and qualitative data, for example by, in the case of interviews, providing a means of gaining insights into collective perceptions and attitudes, as well as the factors influencing them.

Given these potential virtues, along with the fact that the researcher is trained and experienced in leading group discussions, it was concluded that a small number of focus groups could be valuably used alongside the intended semi-structured interviews.

3.2.3.3- Documentary and Statistical evidence

Another important element of the study's methodology involved obtaining of PDO road safety data and the subjecting of these to detailed further analysis. More specifically, the researcher decided to undertake two forms of further descriptive analysis of them. In the first of these, attention is paid to road safety management performance in terms of both safety outcomes and various operational indicators. In the second, the factors that appear to have influenced this performance are reviewed.

The first part of the analysis focused on various types of accident outcomes: Motor Vehicle Incidents (MVI's), Lost Time Incidents (LTI's), Total MVI injuries, and a comparison of work- and non-work-related fatalities. The data in relation to MVIs consisted of overall numbers per month and per year, their types, such as minor, major, fatal and rollover, their location, the contractors and vehicle type involved, and their distribution by time of day, day of week and month of year. The analysis also focused on total annual kilometres driven by both PDO and contractors.

The second part of the analysis focused on data related to various operational indicators, which include defects, classified respectively as A, B, C and D, and compliance with a number of Life Saving Rules (LSR's) violations. The data on the defects included the defect type, location of violation, responsible contractor and vehicle type.

Subsequently, attention was paid to how far four types of policy intervention had influenced the identified performance changes. The first of these related to In Vehicle Monitoring System (IVMS), the second to 'Hearts and Minds' including rollover and seat belt campaigns, driving forums, engagement with the community, Shukran awards and defensive driving. The other two concerned the way in which policies and procedures are enforced by the Road Safety Standards Body (RSSB), and the proactive measures taken by the RSSB in terms of vehicle inspections.

3.2.4- Qualitative data analysis

Qualitative analysis is widely discussed in the literature (Miles, 1979; Robson, 2011; Cassell and Symon, 2004; Bell, 2009; Gray, 2004; Jensen and Allen, 1996 and Silverman, 2004). The description of qualitative analysis is broadly similar in the literature. In what follows the

exposition of Robson (2011) is therefore drawn upon. Robson (2011) discusses three different approaches to qualitative analysis. The first, called quasi-statistical analysis, uses word or phrase frequency and inter-correlations as a method for determining the importance of a concept. The second, known as thematic coding, is a generic approach not linked to any particular theoretical perspective. Here, all or part of the data is coded and similar codes then linked together to form a theme. The themes can then serve as the basis for further analysis or interpretation, either descriptively or exploratory or within theoretical frameworks (Robson, 2011). The third approach is the grounded theory approach, where Robson (2011) suggests the aim is to generate a theory which is centred in the data. This is achieved by three types of coding, first open coding to find the categories, second axial to interconnect them, and thirdly selective coding to establish the main category or categories. These categories may become the basis for a new theory (Robson, 2011; Strauss, 1998; Corbin and Strauss, 2008).

Robson (2011) advices in relation to qualitative data analysis that where there is a substantial amount of data, consideration should be given to using a software package to help the analysis. He further suggests that if the researcher has no experience in analysing qualitative data, the help and advice of someone with experience will be required.

Having reflected on these different analytical approaches in relation to the types of data to be collected and the study's aim and objectives, it was decided that thematic analysis would be used and that its usage would be supported by the use of Nvivo software for qualitative data analysis.

3.3- Operationalisation of methodological choices

Below more detailed information is provided on the utilisation of the three chosen empirical data collection methods – secondary statistics, semi-structured interviews and focus groups.

3.3.1- Statistical analysis

PDO have collated extensive data around driving outcomes and operational indicators. They therefore provided the researcher with an opportunity to pursue various lines of secondary analysis aimed at shedding light on the impact of particular types of management action aimed at reducing the scale and seriousness of driving accidents. In the case driving outcomes, the data available are focused on MVI's and LTI's. In the case of the operational indicators, they provide statistical information on four types of operational defects, classified respectively as A, B, C and D, and on compliance with the already referred to Life Saving Rules (LSR's). In addition, the data enable the occurrence of these operational defects to be classified by their location, and the contractor and vehicle type involved.

The data on MVIs enabled them to be classified by type of accident, for example rollover, front side or rear end collision, jack-knifing, and reversing and collision with pedestrian or animal. They also enabled them to be categorized by a range of potentially contributing factors - driver, age, gender, nationality and driving experience, by the type of vehicle involved and any mechanical defects it had at the time of the accident, by road type (blacktop or graded) and section of the road and by weather conditions at the time of the incident.

Meanwhile, data on LTI's could be broken down by whether they involved fatalities and the types of injury incurred. In addition, the former could also be divided between those that occurred during work-related driving and those that didn't, while the latter could be broken

down according to whether they involved minor first aid or more extensive medical treatment, and whether the injuries sustained led to restricted work cases.

In terms of the operational indicators, the available data from 2008 to 2016 on A, B, C and D defects was analysed. The researcher converted the data on each defect to graph form to identify the trends in each. Similarly, the LSR and NCR data was converted to graph form for analysis. Trends were examined in terms of type of violation and contractors involved. Trends in LSRs and NCRs constituted part of the analysis of performance outcomes. Contractors with high numbers of violations were compared with those involved in MVI's to identify any correlations.

Once the available data had been descriptively analysed, the researcher sought to link identified statistical trends with the various road safety interventions that had been made. The analysis focuses first on performance in terms of both safety outcomes and various operational indicators. It then moves on to examine the factors that appear to have influenced this performance. More specifically, the analysis undertaken by the researcher encompassed the following three main strands:

- Trends in operational indicators and performance outcomes, and their linkages to movements in violations and MVIs and MVI causes
- Influence of road safety interventions on violations (and hence how they have improved both the nature of the safety management system but also its implementation)
- Variations in violations and MVIs between the contractor/ sub-contracting driving populations.

More specifically, a map of PDO road safety performance was developed (see chapter 5) so that possible associations could be identified between the timing of various interventions and identified trends in MVI and LTI frequency rates. The operation of the strategy was assessed by seeking to identify the elements in it that have contributed to the positive outcomes, and highlighted the areas where operational problems appear still to exist.

3.3.2- Operationalisation of Semi-structured interviews

The development of the interview schedule commenced with the identification of four exploratory themes: knowledge and understanding of organisational rules and procedures; the extent of compliance with these rules and procedures; factors that make such compliance difficult; and the extent of compliance outside PDO areas. Associated topic questions were then developed on each of these themes. These questions addressed the following issues:

- Knowledge of laid down policies and procedures relating to driving
- The level of compliance with these rules and policies
- Factors that influence compliance
- How PDO and contractor drivers behave while driving for work
- The reasons why drivers may engage in risky or non-compliant driving behaviour
- Attitudes towards driving and factors influencing them
- Views as to whether staff drive differently when they are not engaged on work-related driving
- Attitudes towards fines and other penalties for non-compliance with rules and procedures
- Data on how often and why they are under time pressure
- Opinions regarding the effectiveness of various road safety interventions

- Areas of potential improvement

It was decided that the interviews should be divided among three groups. The first group consisted of the architects of road safety strategy and policy (PDO staff). The second group consisted of 'road safety implementers' made up of middle managers working for contractors and sub-contractors. The final group consisted of drivers working for contractors and sub-contractors. This selection process approach was based on the grounds of preserving the anonymity of those occupying managerial positions who would otherwise be identifiable.

A small pilot programme of interviews was conducted to test the resultant schedule which involved two participants from each group of the architects, implementers and drivers. This pilot process did not raise any substantive problems with the schedule. It did, however, highlight the risk of the recording device failing and the need therefore to use two devices simultaneously.

Initially, 30 interviews were conducted across all groups on the grounds that this was felt likely to be sufficient given the size of PDO's operations. A further nine were then conducted to confirm that saturation had been reached. The data from these interviews were then thematically analysed aided by NVivo software. NVivo software is a tool that organises qualitative data and supports their rigorous systematic analysis. In approaching this analysis, the researcher wanted to focus on the themes emerging from the participants' answers to the interview questions while also allowing other unanticipated ones to emerge.

The transcribed interviews were first uploaded to the NVivo software platform. Two levels of thematic coding were then undertaken. In the first, labels were added to groups of specific

words, where participants expressed views on accident causation, extent of compliance, compliance outside PDO, influence on compliance and knowledge and understanding. The codes were first grouped according to similarities and differences across the three provider groups. Further context was added to capture what participants said about a particular topic, forming sub-themes. For example, if we take extent of compliance, a search on compliance with rules was conducted and this revealed distinct responses in respect of such issues as compliance level, who complies and why they comply. In the second level of coding the initial codes were grouped together to form specific themes on issues such as speed, mobile phone use, journey management and commuting. For example, here in the second level, we wanted to know about speeding so the words 'why compliance with speeding' were used with the themes on the level on compliance and the reasons why drivers complied emerging. This process was followed for all the above mentioned specific words of the first level coding. The data analysis progressed by abstracting from these sub-themes to central themes emerging across the multiple perspectives.

3.3.3- Operationalisation of Focus groups

The use of the focus groups helped triangulate the data collected by the individual interviews, as well as the PDO secondary data. The use of the focus groups enabled the researcher to dig deeper into certain issues that arose from the interviews. Two focus groups were used consisting of 12 participants per group, made up of a mixture of architects, implementers and drivers. The same interview schedule questions were used with the focus groups, leading to strong discussions and rich data.

3.4 Ethics

The researcher complied with the ethical research policies and practices of Middlesex University, including obtaining the necessary approvals. In particular:

- Obtaining consent for use of the data was gained from PDO senior corporate road safety adviser MSE7, as well as individual consent from the participants
- Right of withdrawal was explained to each participant verbally as well as being included on the consent form
- Anonymisation of data ensured confidentiality and respect of privacy through the use of numeric identifiers
- Secure storage of data was achieved by using a secure server that can be accessed only by the researcher, hard copies stored in s safe
- Primary concern was given to the safety, welfare and dignity of participants, colleagues and the wider community
- Consideration of risks to the participants, such as stress and sensitive topics was undertaken prior to the commencement of the research
- Conflict of interest were considered, however none were identified
- Intellectual property rights were discussed and agreed with stakeholders

Throughout the research attention was paid to the four process imperatives that Holian and Coghlan (2012) argue it is essential for researchers to comply with, namely be attentive (to the data), be intelligent (in inquiry), be reasonable (in making judgments) and be responsible (in making decisions and taking action).

Costley et al. (2010) discuss the role of the worker researcher along with the challenges faced and the considerations that should be made. The position of a worker researcher can potentially present a negative influence which could cloud the research process. By learning through experience and taking a viewing through different perspectives ensured that the researcher

remained objective. Objectivity with colleagues was maintained through engagement and communication, whilst not affecting current roles and responsibilities. While there were some concerns about the power relations between the researcher (senior manager) and interviewee (employee) and the risk of bias in data collection. This was addressed by the researcher reflecting on the culture in Oman and of PDO seen in previous research. In the past employees have 'opened up' to interviewers about their driving behaviour even within an employer setting, providing there were no repercussions. For this reason, the researcher's position in PDO may have been considered problematic, however, upon reflection was confident of using this approach, but aware of the need to make clear issues of confidentiality and anonymity.

Chapter 4: The Case Study Organisation

This chapter provides an introduction to the case study organisation, Petroleum Development Oman (PDO). It begins by providing brief outlines of the organisation's history and the national context within which it operates and manages road safety. It then moves on to detail the structural and policy infrastructures established for the management of such safety. Lastly, it traces the evolution of this policy infrastructure over the period since 1988.

4.1- PDO a brief history

PDO is the foremost exploration and production company in the Sultanate of Oman. Its history can be traced back to 1937 when the Iraq Petroleum Company (IPC) signed a 75-year agreement with the then Sultan Said Bin Taimur. IPC was a conglomerate comprising two multinational companies, Royal Dutch Shell and Compagnie Francaise des Petroles (CFP), now known as Total. In 1950, IPC changed the name of its Oman operation to Petroleum Development Oman (PDO). Shell took over the operation in 1960. Subsequently, 1962 saw the first oil find in Yibal (Clark, 2007) and 1967 saw the first export of oil from Oman. In the same year the 1967 agreement was revised. Under this new agreement Shell now owned 85%, CFP 10% and Partex 5%. In 1970, the current ruler, Sultan Qaboos Bin Said, took over from his father, promising to share the country's wealth with the people. This commitment led in 1974 to the present distribution of PDO ownership, under which the government of Oman owns 60%, Shell 34%, Total 4% and Partex 2% (Clark, 2007). Currently PDO accounts for more than 70% of the country's crude oil production, and nearly all of its natural gas supply.

PDO operates in an area of about 100,000 square kilometres (one third of Oman's geographical area). It has around 130 producing fields, approximately 6,000 producing wells, and a multicultural workforce of around 8,000 employees, comprised of 64 different nationalities. In addition, it employs hundreds of contractors, bringing the total workforce to in excess of 45,000.

4.2- Oman: The national and road safety context

Oman has a population of four million, made up of 2.2 nationals and 1.8 million expatriates and is considered a high-income country. The country is located in the gulf region of the Middle East, bordered on the west by the United Arab Emirates (UAE) and Saudi Arabia, the south by Yemen and the east by the Arabian Gulf. It is 1200 km in length and approximately 550 km in width. Muscat is the capital city with a population of 500,000 inhabitants. Arabic is the country's first language, although English is the first language of the oil and gas industry. As a Muslim country, alcohol is not freely available, and religious beliefs are strong.

Oil and gas production is the main source of income for Oman, with the bulk of production exported to Asia. Most of the population resides in the coastal areas. The interior of the country is desert, and where the oil and gas production is concentrated.

The total length of roads in Oman is 62,987km, of which 49.7% is black top and the remainder graded gravel surface. The country has a road fatality rate of 17 fatalities per 100,000 population, twice as high as the average for high-income countries. According to R.O.P. (2013), 1139 people were killed in 2012, the highest number on record, and 11,618 were injured in a total of 3732 collisions, with 80% of fatalities involving Omani nationals.

Speed is reported to have been main factor in 52% of all fatal crashes in 2014, followed by dangerous overtaking at 15% and neglectful driving at 10% (R.O.P, 2015).

A number of other statistics reinforce this picture of poor driving safety. In 2013 there were 3,254,799 speeding tickets issued, this corresponding to three speeding tickets per driver. In a similar vein, while there are laws in place prohibiting the use of handheld mobile phones when driving, in the same year there were 20,494 offences relating to drivers using hand held mobile phones, (R.O.P. 2013). Such statistics point to the fact that current penalties for driving offences are insufficient to generate widespread compliance. This is borne out by the impact of a new law under which driving through a red light results in an automatic 24-hour custodial jail sentence. Thus, following this law's introduction, red light offences in 2013 declined by 75% to 1011 cases.

4.3- Road Safety within PDO

The PDO concession area spreads over 100,000 square Kilometres and is geographically a similar size to the UK. PDO is responsible for building, maintaining and managing the safety of the road infrastructure within it. These roads, which the public also has access to, join up with the government roads. The PDO road network consists of 1995 km of blacktop and 16,415 km of graded surface, including main and minor roads. The disparity between the number of blacktop and graded roads is largely due to the nature of drilling and production operations. Once these have been completed in an area, the road may not be needed or used very infrequently. For economic reasons it will not therefore be paved.

PDO has in place a wide-ranging set of policies and procedures relating to all aspects of road safety, which also apply to their contractors and sub-contractors. In addition to this,

the organisation has its own Road Safety Standards Body (RSSB). The RSSB has two components, one is the Road Safety Standards Team (RSST) whose role is to enforce driving rules and regulations through vehicle spot checks, speed monitoring, and contractor auditing, as well as on scene crash investigation and reconstruction. The other component is the Defensive Driving Assessment Team (DDAT) whose role is to conduct driving assessments and issue the successful delegates with a PDO driving permit. The DDAT monitors and audits the defensive driving training providers, as well as the development of the training material. The RSSB, which is contracted to a third-party contractor, is monitored by PDO's corporate road safety department and has a presence at all PDO operating locations.

PDO's general safety philosophy can be summarised by their target 'Goal Zero' and the aim therefore to cause no harm to people, assets or the environment. The focus areas for achieving 'Goal Zero' are work site hazards, road transportation, contractor HSE management and office safety. To support this goal, twelve Life Saving Rules (LSRs) were introduced in July 2009. These particular rules were selected because they represent the activities within PDO operation that present the highest likelihood of causing death or serious injury. They lay down the following requirements:

1. Obtain a valid permit to work whenever required for the task at hand
2. Do not walk under a crane or suspended load
3. Conduct gas tests whenever required
4. Do not light cigarettes, cigars or pipes in no-smoking areas
5. Verify isolation before work begins and use specific life-protecting equipment
6. Follow the prescribed safe journey management plan
7. Obtain authorisation or a valid permit to work before entering a confined space

8. Wear seat belts when in a moving vehicle
9. While driving, do not use a mobile phone and do not exceed the speed limit
10. Obtain authorisation or a valid permit to work before overriding or disabling safety equipment
11. Use specified fall-prevention equipment when working at heights
12. Do not drive or work under the effects of drugs or alcohol

The objective of these rules is to set out clear and simple "do's and don'ts" focusing on the activities that present the highest potential safety risk. They exist alongside a consequence matrix (see further below) detailing penalties for non-compliance with them, and the following three 'Golden Rules' setting out how staff and contractors should behave at all times:

1. Comply with the law, safety standards and procedures
2. Intervene to prevent unsafe or non-compliant actions
3. Respect fellow workers and the community in general.

PDO's main relationships are between their direct staff and their direct contractors. In terms of road safety PDO manages their contractors in the same way they manage their own staff. However, further to this, contractors then have relationships with sub-contractors, some of which are independent Oman Truck Operators (OTO's) and who may in turn have their own contractors. The government is encouraging the use of OTO and local sub-contractors due to political pressures from these groups. As discussed below, this trend towards increased sub-contracting has potential (and actual) implications for the extent of management control that PDO is able to exercise

The PDO road safety strategy focuses on what are considered key areas of risk relating to drivers, vehicles, road conditions and the driving environment. It embodies a hierarchy of controls. This commences with the elimination of journeys where possible, moves on to the selection of lower risk transportation modes, and finally imposes safety-related requirements on drivers, vehicles and the management of journeys. More specifically, PDO manages road safety through a seven-pillar holistic approach encompassing leadership and commitment towards the management of road safety, In Vehicle Monitoring System (IVMS), vehicle specifications, journey management, commuting of workers from work locations to their homes, driver competency, behaviour and fatigue, and finally the road worthiness assurance (RAS) of vehicles. The standards for these seven pillars are in turn clearly outlined in PDO's main road safety documents SP2000 v4 and SP2001, as well as other related policies, procedures and guidelines, all of which are discussed below.

4.4- SP 2000

The purpose of SP2000 is to set out minimum road safety standards in order to manage and reduce the risks associated with road transportation that apply to the operator, contractors, sub-contractors and service providers involved in the execution of PDO contracts. The document specifies a range of general requirements and obligations. It then details a host of more specific ones relating to driver eligibility, training, fatigue management, vehicle requirements, In Vehicle Monitoring Systems (IVMS), journey management and commuting, night driving, and performance evaluation and monitoring (P.D.O., 2017).

4.4.1- General Requirements

SP2000 makes clear that all drivers, vehicles and equipment must comply with the laws of the Sultanate of Oman, and the Royal Oman Police (ROP) traffic rules and regulations,

thereby making clear that the Laws of the Sultanate will supersede any conflicting requirements laid down in SP2000. It also requires compliance with Royal Society for the Prevention of Accidents (RoSPA) driver training standards, British Ministry of Transport (MOT) standards for Road Worthiness Assurance Standard (RAS), various European Union (EU) standards for tankers, United Nations (UN) standards for buses and the road safety management requirements of the International Standards Organisation (ISO) 39001.

At a more detailed level, a range of general requirements are imposed on those involved in PDO road related operations, whether as a driver, pedestrian or vehicle occupant. The first requirement is that while on the road, all must behave in a way that does not disturb, endanger or harm people or assets. The second is the obligation to predict and compensate for the mistakes of other road users, in order to reduce the potential for danger. Finally, all mentioned road user groups are placed under an obligation to help other road users when required, insofar as this can be done without creating another risk.

SP 2000 further obliges both PDO and contractors to develop a road safety programme that aligns with the standards detailed in it, and states that service providers working or participating in the road safety area, such as those engaged in training, certification, product supply, and maintenance, must also comply with the laid down standards. It is additionally made clear that it is the responsibility of PDO to review SP2000 in the light of any applicable changes, and to produce and share an annual report on achievements, statistics and challenges related to road safety.

4.4.1.1- Driver eligibility

The general eligibility requirements for drivers, distinguishing between such categories of drivers as professional, HGV, Bus and emergency response, are detailed, along with the minimum ages and years of experience required to drive particular vehicles. The same is the case for the roles and responsibilities of drivers in relation to such matters as checking the vehicle, driving in adverse weather, the procedure to follow if involved in a road traffic accident or breakdown, speed management, use of IVMS, driving hours and rest periods, and speed limiters. Night driving is an exceptionally high-risk activity in the concession areas, and is not permitted, with the exception of certain activities and emergencies. Where such driving is required, the responsibilities of the driver are outlined in the PDO's night driving procedure discussed further below. Finally, requirements are laid down in respect of the annual medical examination that must be undertaken and passed by drivers in order for them to be considered fit to work.

4.4.1.2- Training

PDO require all drivers operating in the concession areas to hold a defensive driving permit. This is obtained once the relevant training has been completed, and a separate driving assessment has been conducted and passed. There are two main reasons why PDO introduced its defensive driving training. Firstly, the current ROP driving test in Oman focuses on the basic technical skills of controlling the vehicle. These skills are part of lower levels of the Goals for Driver Education matrix (GDE), a framework to structure driver training as outlined in Hatakka et al. (2002), and so does not address the higher levels aimed at behaviour and lifestyle. Research tells us that driver behaviour is the main factor in road traffic accidents, hence the need to focus on the higher levels of the GDE matrix. Secondly, as a means of standardising driver standards across a multicultural organisation made up of

eighty different nationalities. The two cornerstone Defensive Driving (DD) courses are light vehicle blacktop and heavy vehicle blacktop. All the other courses, such as those dealing with driving on graded roads and driving more specialist vehicles like buses, tankers, fire tenders and ambulances, are add-on to the above-mentioned courses, which can only be sat after successfully completing DD01 or DD02, depending on the vehicle category.

4.4.1.3- Fatigue Management

PDO operations on occasion are undertaken outside ordinary working hours. More generally, activities often involve shift work, extended hours and on-call arrangements. These working arrangements may contribute to fatigue if not managed appropriately.

The SP2000 document sets out the requirements and procedures relating to how PDO and contractors should schedule trips; roster drivers; establish a driver's fitness to work; educate drivers on fatigue management; manage incidents on, or relating, to commercial vehicles; and establish and maintain appropriate workplace conditions. The document suggests that the success of managing fatigue is dependent on a joint effort between management and drivers and that a fatigue management framework should be developed. However, SP2000 does not itself contain a specific driver fatigue policy or management plan. Fatigue is, however, covered as part of other policies. For example, fatigue guidelines are given for various operational activities including driving, and awareness campaigns are run periodically. Having said this, since the commencement of the present study a driver fatigue management policy and plan has been developed, and is currently in the implementation process.

4.4.1.4- Vehicle requirements

The vehicles operating in the PDO concession area face greater risk than those operating outside it due to the nature of the terrain and the operational activities. SP2000 therefore lays down safety requirements additional to those laid down by the Oman government to help minimise these risks. These standards cover a broad and detailed list of vehicle requirements and equipment. Some of the critical items worth mentioning are tyres, where the focus is on age, wear, tread depth and temperature ratings, the type and condition of seat belts, provision of rollover cages, and lighting and emergency equipment. It should be noted that different standards are specified in relation to light vehicles, heavy vehicles, buses, ambulances, trailers, tankers and escort vehicles.

To assure the above-mentioned vehicle standards are in place, PDO introduced an annual RAS inspection, which applies to all vehicles with a capability to travel over 60 km/h in its concession area. The responsibility to ensure the required vehicles meet and pass the RAS inspection lies with the company in ownership, lease, loan or hire of the vehicles. A network of approved RAS inspection workshops are in place throughout the concession area, and the coast. Each approved workshop is legally bound, and accountable for any discrepancies or fraud related to issuing RAS stickers. PDO assures the standards of these workshops firstly through an initial approval process, followed by annual audits and monitoring visits.

4.4.1.5- In Vehicle Monitoring System (IVMS)

IVMS is a technology-based system, which has the capability to monitor and record driver and vehicle activities. It can be fitted to most vehicles including trailers, plant and equipment, and has further advanced capabilities to track maintenance, depending on the requirements of the user. IVMS was introduced in all PDO contracts after 2008. Under the

system, each driver is assigned a specific key that enables their driving performance to be monitored in real time in relation to such matters as harsh braking, harsh acceleration, speeding, unauthorised night driving and non-wearing of seat belt. Adverse events identified are then categorised by colour, red, amber, and green, leading to the acronym (RAG). Red signifies a violation has occurred, amber highlights a pattern that could lead to a violation, and green implies driving is normal. PDO and their contractors are required to produce monthly RAG reports that are to be used to provide feedback and coaching to drivers as required.

The main components of the system are outlined, including the roles and responsibilities of IVMS management, including those of the PDO contract holder, IVMS focal point, line supervisors, contractors, drivers and vehicle maintenance staff. The need for appropriate training is highlighted to assure competency in the following areas, managing notifications, feedback, reward and consequence management.

SP2000 outlines the requirements of IVMS vendors, along with the capability of both the hardware and software to be provided. Each vendor has to undergo an audit to assure its products and services meet the required PDO standard. The requirements and the location of the server used by the vendor are outlined clearly. The recordable data availability should be 100%, downloading every 15 minutes while in network coverage. Other requirements outlined relate to data backup, map updating and server maintenance notifications. Full details of the standard for the installation of the hardware are given, including the qualification requirements for installers. The document also refers to the requirements for geofencing speed limits throughout the operational area

A further vehicle safety feature that is used in conjunction with IVMS are dual speed limiters. These limiters automatically prevent the vehicle going over the maximum speeds in geofenced areas. The details on anti-tampering and conformity requirements are also clearly outlined. For assurance of compliance, each contractors IVMS managements system is one of the seven pillars audited annually by the RSST.

4.4.1.6- Commuting and Journey management

Because of the geographical size of the PDO concession area, the workforce is required to operate on a rotational basis, where workers reside in the accommodation provided at their work location for the duration of their shift, usually two weeks on followed by two weeks off. Commuting within PDO operations therefore refers to when these staff and contractors are travelling between their home and their work location in the field. As a means of reducing the risk of this, all PDO staff and contractors are required to use the approved air or bus services, and are discouraged from using private vehicles.

PDO have in place a comprehensive road and air transport system for commuting workers. For road transport a series of pick-up and drop off points, known as commuting hubs are in place around the country. Further to this PDO operates three airports in the concession area with multiple daily flights to and from the capital Muscat. These commuting arrangements do not, however, apply to those working and living in the Muscat area since such travel is not viewed as work-related.

The detailed commuting procedure is contained in annex C-5 within SP 2000 and makes clear that it is the responsibility of operators and contractors to arrange the transport for their staff, using either flight or approved heavy buses, if the distance is greater than 200

km. To support compliance with this procedure, contractors are required to maintain details of where all their employees reside, their primary work location and the means of commuting. It also requires them to encourage staff to use the commuting transport provided, and discourage the use of private vehicles; although the document does allow private vehicles to be used where an employee's primary residence is within one hour's drive of their work location, providing this has been approved.

Journey management was first introduced in PDO over twenty years ago in reaction to the death of an employee who lost his way in the desert. It therefore seeks to avoid such a reoccurrence by putting a system in place to manage all journey's over 20 km. The detailed procedure for journey management is located in annex C-3 of SP 2000.

The procedure first details exceptions to the journey management policy, such as journeys under 20 km, convoys, journey's between rigs and their camp, and journey's within Muscat. It then describes the components of the journey management process, and the roles and responsibilities of all those involved the process, including the authorising person, the journey manager, the location journey manager and the driver.

Central to the policy are the development of a journey plan, and the undertaking before this, of various safety-related activities. These activities encompass checking the necessity of the journey, the condition of the driver and vehicle, the correctness of route selection, the provision made for breaks, and communication, and the reminding of the driver of their responsibilities, as well as the procedures to follow in case of an emergency. The policy also requires journeys to be monitored, including via IVMS, communication with the driver at agreed times, as well as communication with the location (destination) journey manager.

It further details procedures to be followed if a driver has not responded within 120 minutes of an agreed reporting time, and following an accident. Another important feature of the journey management policy is that it specifies the maximum number of journeys that can be managed by a journey manager at any given time.

4.4.1.7- Night Driving policy

The main risks associated with night driving in the interior locations are fatigue and the potential for collision with animals due to restricted vision, as no street lighting is in place outside the camp areas. In the light of these, PDO's night driving policy states that work should be planned so as to avoid such driving, and that it can only be undertaken after explicit approval from PDO has been obtained. Where night driving is unavoidable, the policy outlines a number of preventative measures to mitigate the risks involved. These measures require each contractor to have a night driving policy that details relevant roles and responsibilities, and how the risks associated with night driving are to be managed and controlled. It is made clear that, at a minimum, these controls must include a 24/7 journey management system with live IVMS journey monitoring, route hazard surveys and use of well rested dedicated night shift drivers.

4.4.2- Performance, evaluation and monitoring

In addition to the above SP2000 also contains requirements related to road safety compliance and details the consequence management matrix that applies to cases of non-compliance. The requirements and intervals for both internal and external audits to verify compliance, continual improvement and management commitment are outlined. Furthermore, it is clearly stated that all events affecting road safety must be investigated to determine their root cause, followed by the undertaking of appropriate remedial action. The

PDO consequence matrix list the offences from the most serious to the minor, with the consequences ranging from dismissal to verbal warning, depending on the severity and the number of reoccurrences. Contractors must have their own consequence matrix that complies with the matrix outlined in SP 2000 (P.D.O., 2017).

PDO have established a number of key performance indicators (KPIs) to measure road safety performance. These are detailed under six main headings, with further detailed sub headings. These encompass:

- Injuries including fatalities both work and non-work related
- Lost Time Incidents (LTIs)
- MVIs including both severe and minor
- Rollover MVIs
- Risk exposure consisting of KM driven, followed by the MVI frequency rate per million KM driven
- IVMS to monitor driver behaviour in terms of IVMS RAG reports.

Motor vehicle incident investigation is a critical element of road safety, firstly to establish the root cause, secondly to share the learnings. All MVIs must be investigated by the RSST and as part of any investigation IVMS data which is useful in identifying the immediate, and root cause of the incident should be communicated to the investigation team. A seven-pillar audit tool is used to determine the level of compliance with PDO road safety policy and rules and highlight areas for improvement. However, contractors that are deemed high risk, as determined by their road safety performance, are audited annually by the RSST itself.

4.5- SP 2001

PDO operations rely heavily on the road transport of cargo and heavy equipment to remote locations. The purpose of SP 2001 is to set out procedures and specifications for restraining all types of loads to reduce the risk of improperly secured loads contributing to an MVI. It applies to those involved in the transportation of cargo and equipment, including PDO staff, contractors, sub-contractors, vendors and suppliers. The responsibilities for ensuring compliance with this specification are clearly stated and extend to encompass asset managers, corporate functional discipline heads, contract holders, contractors, contract and procurement staff, transport supervisors and finally the driver. SP2001 also lays down requirements regarding vehicle selection and load restraint (P.D.O., 2001).

4.5.1- General requirements

Selecting the appropriate vehicle is the first step in the process of ensuring the safe securing of the load. The requirements for vehicles include, the design and construction, for example wooden or steel deck, open or closed body, high bed low bed and appropriate restraint anchorage points, suitable for the particular task. Further factors mentioned include the maximum carrying capacity and dimensions of the vehicle to prevent overloading and overhanging loads. For the transportation of bulk liquid and loose material, vehicle selection should consider the avoidance of load movement, and material blowing or falling off the vehicle. he greater part of SP2001 outlines in detail the principles of load restraining. The document first explains the principles and the requirements, and then goes on to discuss the various forces acting on vehicles that can cause load shifting. The document outlines in great detail all the various restraint equipment and its application to particular loads. All the safety issues associated with load restraint are detailed, along with the particular procedure that must be followed in order to reduce the risk of injury or asset damage. Further to this,

the inspection process is listed, for each of the mentioned restraints. Details are provided on load heights, considering the maximum clearances of bridges and powerlines as well as the issue of Centre of Gravity (CoG) for maximum stability, Real everyday scenarios with pictorial examples are used to help understanding of the principles and the importance of load restraint.

4.5.2- Evolution of policy infrastructure

Over the years the PDO's road safety policy infrastructure has evolved as a result of a range of interventions. The most important of those made since 1988 are summarized below in Table 4.1

Table 4.1: Evolution of PDO policy infrastructure

Year	Intervention
1988-1999	Introduction of road safety policies, • Journey management • Driving standards • Vehicle standards
2000-2004	• Introduction and implementation of more robust road safety policies and procedures such as SP2000 and SP2001. SP2000 states requirements for drivers and driving covering comprehensive rules, journey management, commuting, road worthiness assurance standard (RAS), Rollover protection equipment, speeds, convoys, Ambulance rollover and road safety consequence matrix. • SP2001 load refers to safety and restraining, including general requirements, principles of restraining, securing specific loads and hazardous goods. • Introduction of defensive driver training • Further hearts and minds campaigns • Introduction of Road safety monitoring and accident investigation team
2004-2006	• Introduction of Rollover simulators and seat belt convincers • Ongoing defensive driver training and hearts and minds campaigns
2006-2008	• Engagement with local communities on road safety • Introduction of speed radars on PDO roads • Introduction of Shukran awards for good driving behaviour

2008-2011	• Introduction of the Road Safety Standards Body contract (RSSB) with wider scope of work. • Introduction of In Vehicle Monitoring System (IVMS) • Introduction of A defects with consequence matrix • Driving forums • Introduction of PDO Life Saving Rules (LSR) • Introduction OF PDO Golden rules • Auditing contractors on road safety • Accident investigation and analysis • Introduction of 2 day defensive driving training and the appointment of one training provider and separation of training and assessment • Increased Shukran awards • Ongoing hearts and minds • Ongoing rollover and seat belt convincer campaigns
2011-2013	• Introduction of new behavioural based defensive driving training material • Re-established driving forums • Establishment of the 'Tell a friend campaign' • Ongoing hearts and minds • Ongoing rollover and seat belt convincer campaigns

2013-2016	• Introduction of revised commuting procedures • Introduction of revised IVMS procedures • Introduction of commuting campaign • New proactive approach by RSSB to contractors in terms of vehicle inspections • Tyre safety campaign 'hearts and minds' • Tyre study by TRL • Ongoing hearts and minds • Re-energised rollover and seat belt convincer campaigns
1988-2016	All of the above

As can be seen from table 4.1 above the PDO road safety journey began approximately 30 years ago beginning with policy documents on the driver, vehicle and journey. Over the past 30 years these policies have been implemented and enhanced, and are under continuous review to improve road safety performance as well as incorporating industry and national changes. A long with these policies a range of road safety interventions have been implemented discussed in a later chapter. In parallel to the policy evolution PDO rod safety performance has seen a dramatic improvement going from 2.66 MVIs per million kilometres driven 1988 to just 0.33 in 2016, which is notably globally.

Chapter 5: The PDO Road Safety Performance: A Secondary Analysis

5.1- Introduction

This chapter sets out to analyse the road safety performance of Petroleum Development Oman (PDO), focusing on the years 2008 to 2016. The analysis is based primarily on comparisons and trend analyses undertaken by the researcher on internally available secondary data. It focuses first on performance in terms of both safety outcomes and various operational indicators. It then moves on to explore the factors likely to have influenced this performance.

5.2- Performance

In what follows PDO's road safety performance is assessed in two main ways. First, an examination is undertaken of trends in a number of accident measures. Secondly attention is paid to trends in a number of operational indicators that shed light on the extent to which laid down rules and procedures are complied with and hence the rigor with which they are implemented. These latter measures, as will be explored in more detail later, can therefore be argued to indicate variations in the protective capacity of the laid down safety management system. This second analysis centres on statistics relating to four types of operational defects, classified respectively as A, B, C and D, and compliance with a number of Life Saving Rules (LSR's).

5.3- Outcome measures

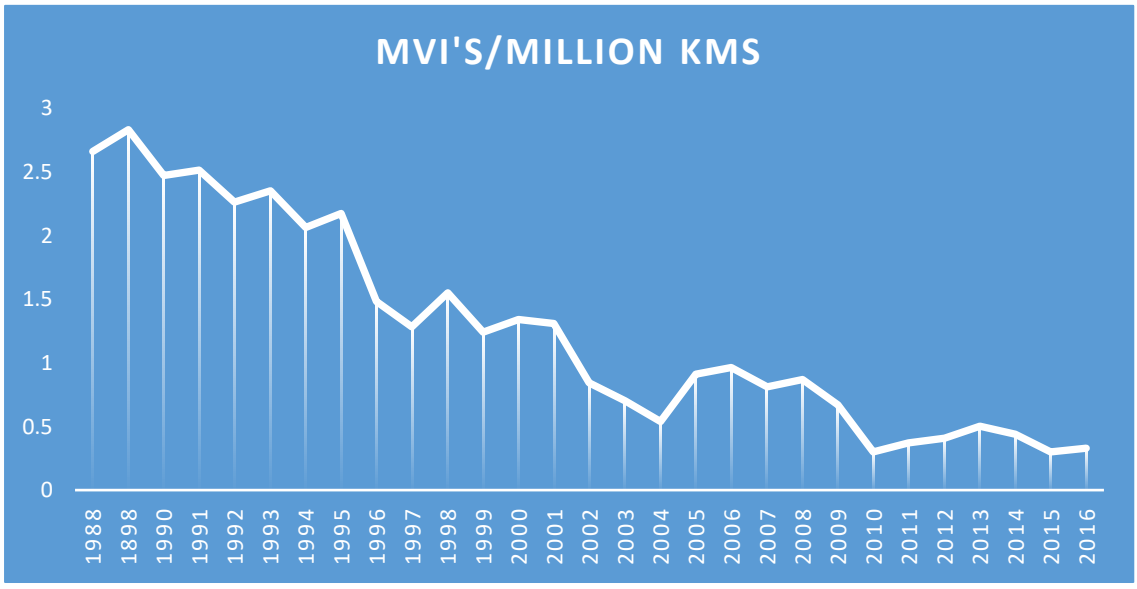
In the first of the above areas attention in what follows is focused on trends in four sets of outcome measures: Motor Vehicle Incidents (MVI's), work- and non-work-related fatalities, Lost Time Incidents (LTI's) and Total MVI injuries.

5.3.1- Motor Vehicle Incidents (MVI's)

Trends in MVI's within PDO are examined first, for the period 1988 to 2016 as a whole and then by focusing more narrowly on the years 2008 to 2016 due to the collection of more reliable data following the inception in 2009 of the current Road Safety Standards Body (RSSB) and the MSE 7 corporate road safety team.

A positive downward trend in MVI's per million kilometres driven is clearly visible in the Figure 5.1 below. Thus, the graph shows a reduction from 2.66 MVI's per million kilometres driven to 0.33 between 1988 and 2016, representing an 87% reduction. However, within this overall downward trend periods of improvement and deterioration are apparent.

Figure 5.1 – MVI's per million kilometres driven



The years 2000 to 2004 saw a decrease in MVI's from 1.34 to 0.54 per million kilometres driven, representing a 60% reduction. Subsequently, the period between 2004 and 2006 saw a deterioration in the MVI rate, with it going back from 0.54 to 0.91, thereby essentially eliminating much of the improvement made between 2000 and 2004. The period 2008 and 2011 then saw a very significant reduction in the MVI rate from 0.87 to .03 accidents per million kilometres driven. This represented a 65% reduction, bringing the MVI rate to its lowest level in the company's history. The period between 2011 and 2013 then saw an increase in the MVI rate from 0.3 to 0.5 per million kilometres driven, an increase that was subsequently reversed between 2013 and 2016, to bring the rate to 0.33.

5.3.1.1- Types of MVIs

MVI's within the PDO operation are classified into ten different types, listed below in Figure 5.2. A rollover is where a vehicle rolls over on its roof at least once. A rear end collision is where one vehicle strikes another in the rear. A side collision is where one vehicle strikes the side of another with the front of their vehicle. A frontal collision is where two vehicles strike each other from the front, also known as a head-on. A side swipe is where two vehicles collide with each other along the side of the vehicle. A run off road is where a vehicle leaves the main road but remains on its wheels. An animal collision is a collision between a vehicle and an animal, while a pedestrian collision involves, as its name also suggests, contact between a pedestrian and a vehicle or its equipment. A jack-knife is where the trailer begins travelling faster than the drawing vehicle causing the unit to be pushed to one side.

Figure 5.2 below shows the distribution in percentage terms of total MVIs between the 10 different types of incident for the period 2009 and 2016. As can be seen, rollovers are by

far the most frequent type of MVI, representing more than 50% of total incidents. Meanwhile, only two other types of incident – rear ends and side collision – contribute more than 10%

Figure 5.2 – The percentage each type of MVI represents in PDO operations between 2009 and 2016

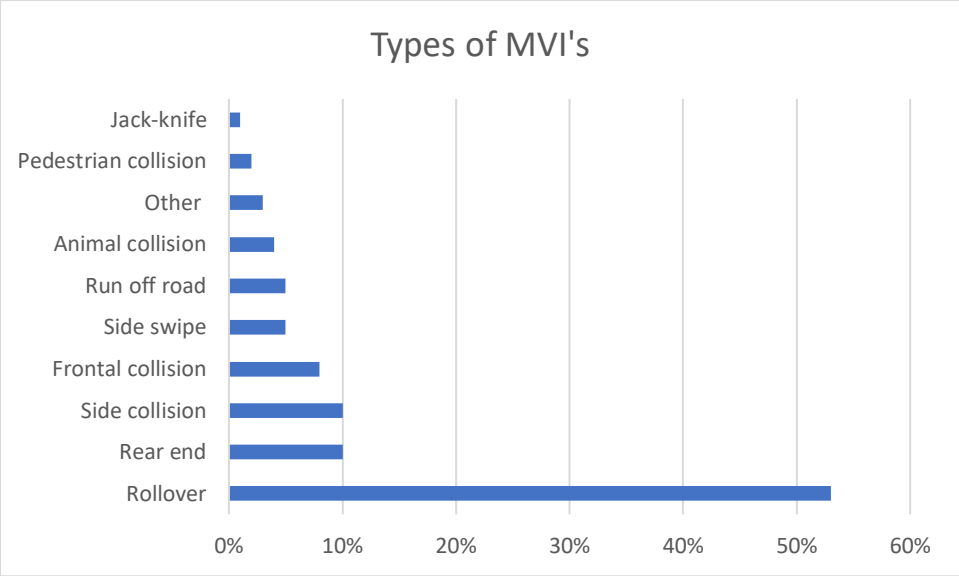
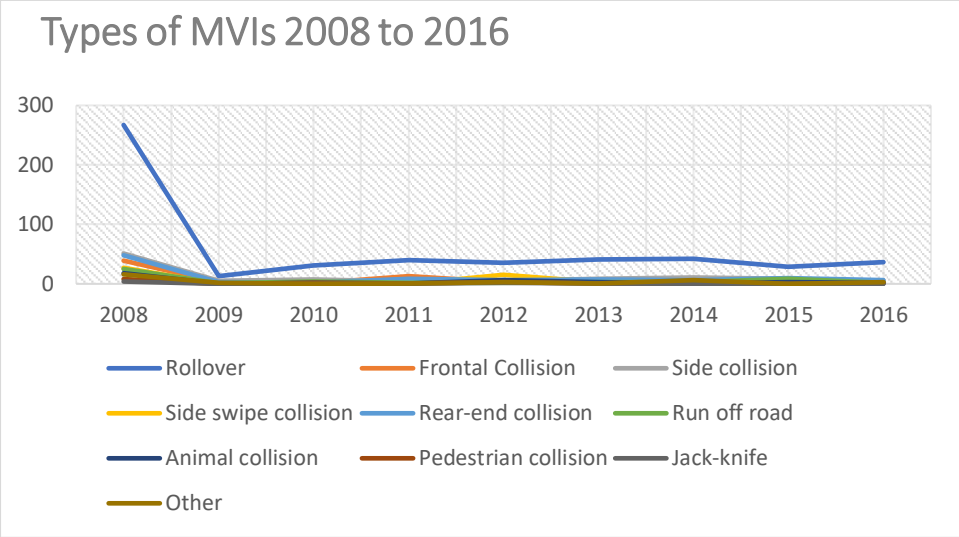


Figure 5.3 goes on to present the trends in the various types of MVIs between 2008 and 2016. What is clear is that all types of MVIs followed a similar dramatic downward trend between 2008 and 2009, and there after some plateaued while others continued a less dramatic downward trend. While rollovers continue to represent the largest type of MVI in PDO, between 2008 and 2016 their number reduced by 50%. Others such as rear-end, frontal and animal collisions also reduced by the same percentage. Side collisions saw an 94% reduction, while run off road incidents saw a 92% reduction during the same period.

Figure 5.3 – The trend in types of MVIs between 2008 and 2016



When this picture is compared with that for non-work-related rollovers significant differences emerge that serve to suggest that PDO's management of road safety does have a positive effect. Thus, as can be seen in Figure 5.4 the trend in non-work-related rollovers is found to be increasing, in contrast to the downward trends for work-related ones shown in Figure 5.5.

Figure 5.4 – Rollover private vehicles non-work-related 2010 to 2016

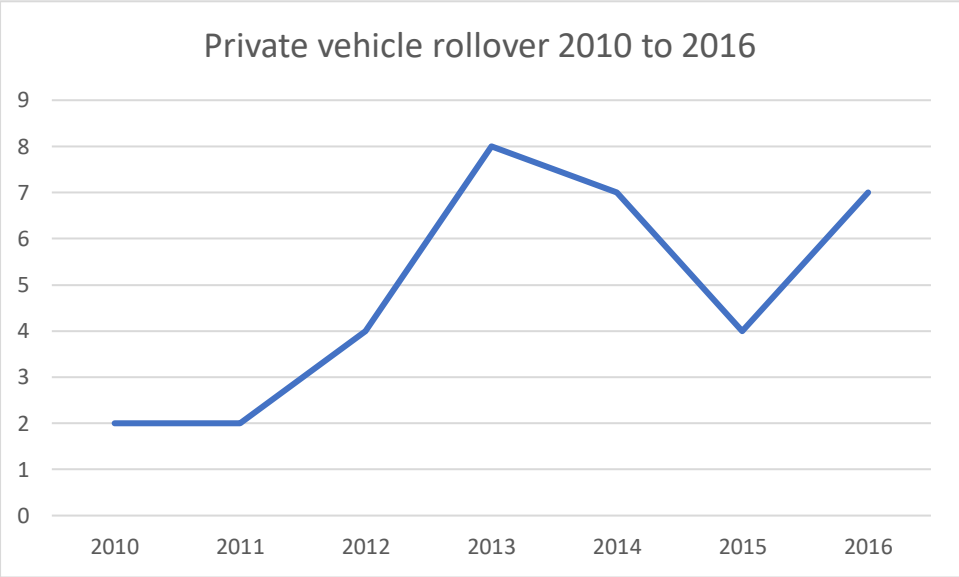
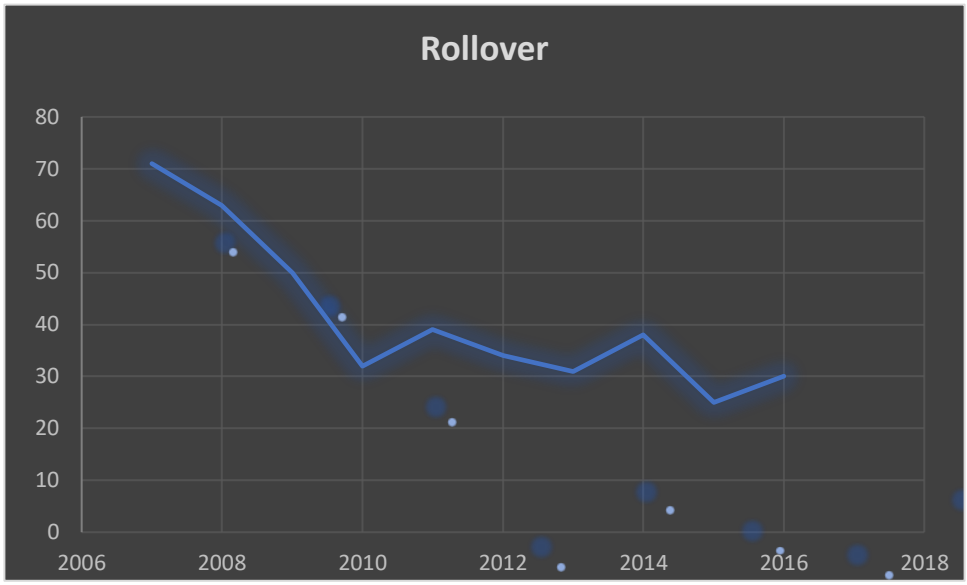


Figure 5.5 – Rollover in PDO operations 2007 to 2016



Work and non-work-related fatalities

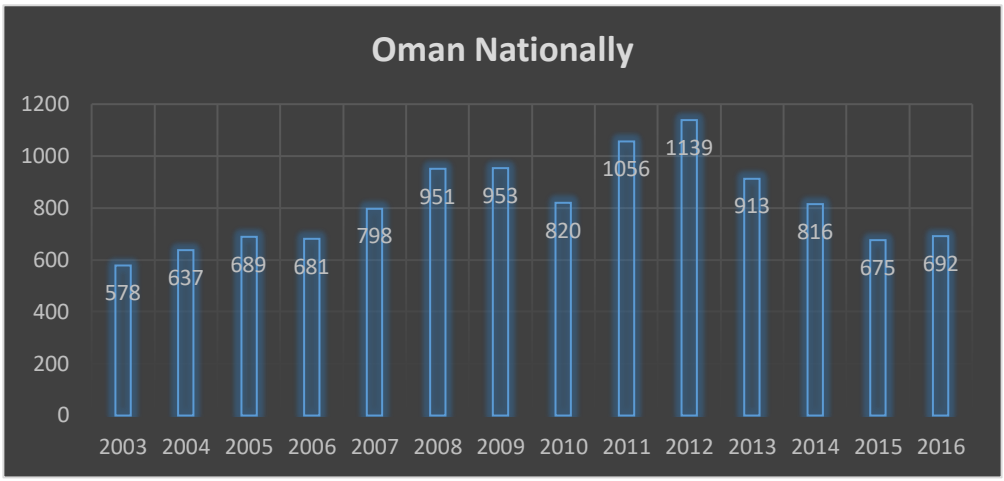
The definition of a PDO work related road traffic fatality is a fatality that occurred during a work connected journey and involved PDO or contractor staff in a work-related vehicle. Work related fatalities do not encompass those that occur commuting to and from an employee's home, but do include those occurring during travel between living accommodation and worksites in the interior.

Figure 5.6 – PDO Work related road fatalities 2008 to 2016

As can be seen from Figure 5.6, looking at the period 2008 to 2016, with the exception of 2008, the figures for work-related road fatalities remain low, with three of the years showing zero fatalities. Furthermore, given that number of kilometres driven during this time increased by 53 million it can be argued that the figures indicate an improvement in safety management performance.

Figure 5.7 below presents the road traffic fatality rates in Oman between 2003 and 2016. Drawing comparisons between PDO work related road fatalities and the national fatality rate, some interesting trends emerge. During the period 2008 to 2012 Oman road fatalities were increasing at an alarming rate, going from 951 in 2012 to a peak of 1139 in 2012 (see Figure 5.7 below). The only exception to this was 2010, when there was a reduction to 820 fatalities. During the same period the PDO road traffic fatality rate was decreasing, thus demonstrating a very positive, relative, performance by PDO.

Figure 5.7 – Road deaths in Oman



Non-Work-related Traffic Fatalities

The definition of a non-work-related road traffic fatality is a fatality that occurs during a non-work-related journey that was made outside working hours and not in a company vehicle. Non-work road traffic fatalities usually involve PDO staff and contractors not using the approved commuting transportation provided but instead using private vehicles to travel.

Figure 5.8 – PDO Road fatalities 2003 to 2016

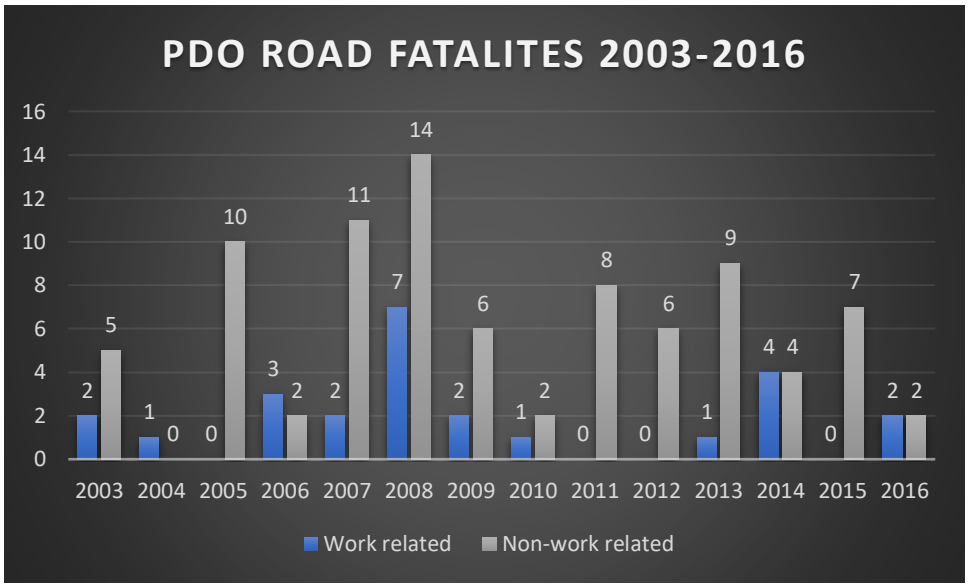


Figure 5.8 above presents a comparison between work related and non-worked related road traffic fatalities in the PDO area of operation between 2003 and 2016. It is clear that the number of non-work-related fatalities is significantly greater than work related ones. The number of non-work-related fatalities is furthermore erratic and does not follow a clear pattern.

5.3.3- Lost Time Injuries (LTI's)

Within PDO Lost Time Injuries (LTIs) are defined as encompassing fatalities, permanent total disabilities, and lost workday cases. They therefore provide a different measure of performance to MVI's since a single MVI may involve more than one LTI. For example, if twenty people receive such injuries in one MVI, this is recorded as twenty LTIs. LTIs therefore provide a measure of the impact of an accident or incident. There are two types of LTIs recorded in PDO operations. The first one is associated with LTIs occurring in all operations (worksite Drilling Rigs, production plants, Wells, pumping stations and offices) except those associated with a road going vehicle. The second specifically relates to LTIs involving road going vehicles, which are defined as any vehicle that can travel above 40km/h.

Figure 5.9 – LTI and MVI rates compared to kilometres driven

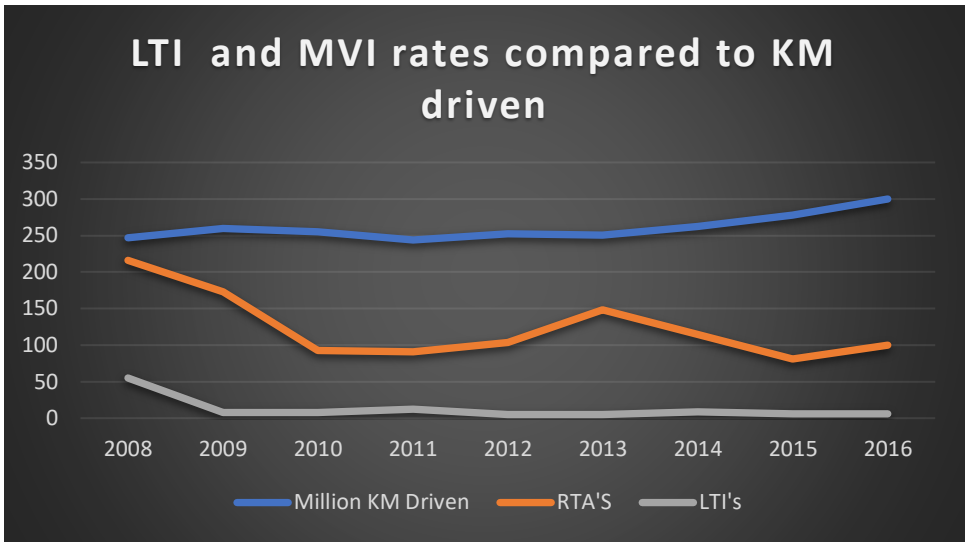


Figure 5.9 above compares the road traffic LTI rate with both kilometres driven and the number of MVI's. It is evident, with the exception of 2008, that the LTI rate has remained low and consistent, notwithstanding that kilometres driven increased from 216 million in 2008 to 300 million in 2016. Given that an increase in kilometres driven involves a rise in risk exposure, the consistency of the LTI rate points to a significant improvement in performance. In a similar vein, while the MVI rate exhibits a degree of fluctuation around an overall declining rate, the LTI count remains low and consistent, further demonstrating consistent overall performance improvement.

What is noticeable in Figure 5.10 below is that both the road traffic LTI and work-site LTI frequency trend follows a similar overall downward trend encompassing periods of improvement and deterioration. In contrast, road traffic MVIs have remained at a consistently low level. Furthermore, when the MVI frequency rate was increasing, the road traffic LTIs continued to decline, (Figure 5.11) further highlighting the possible influence of certain interventions discussed in more detail below.

Figure 5.10 – Overall LTI's

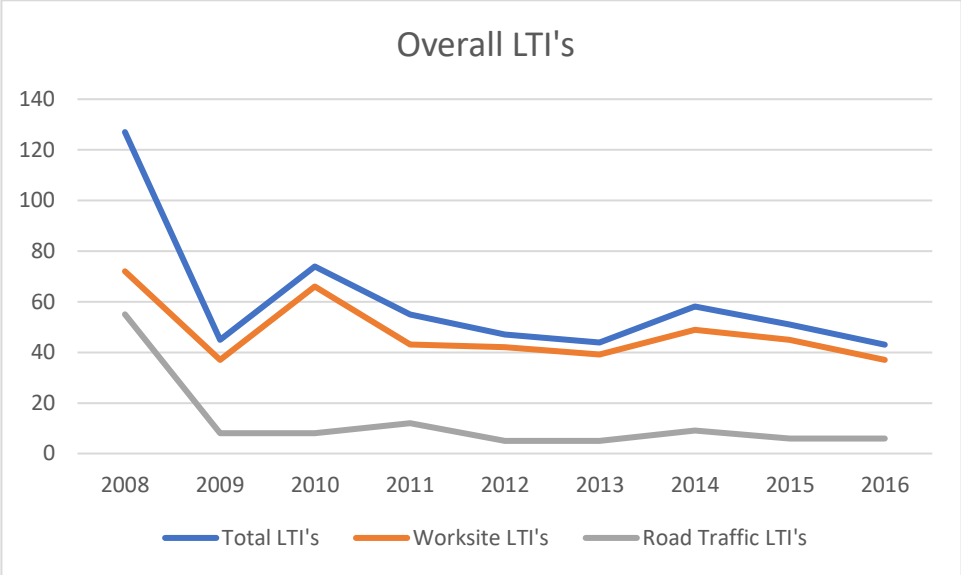
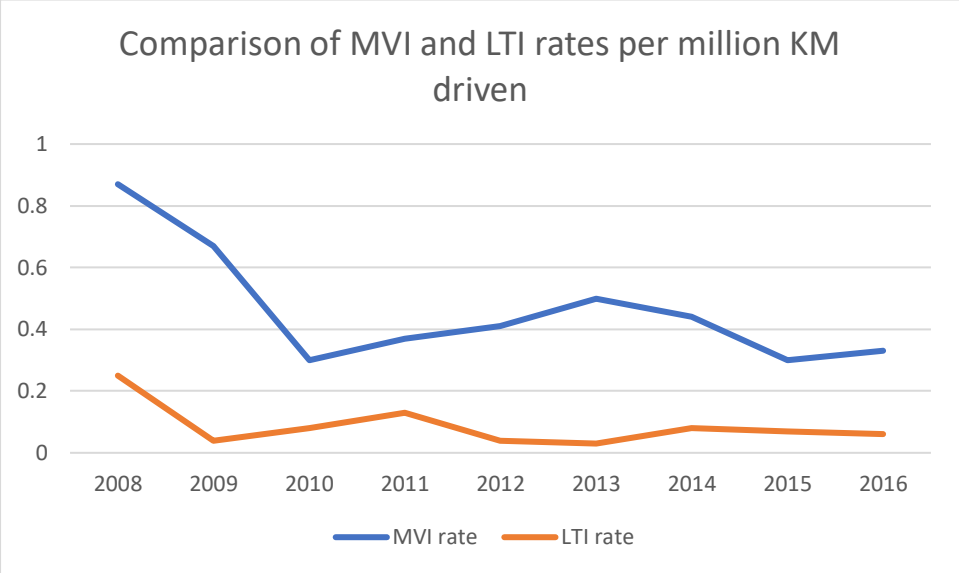


Figure 5.11 – Road traffic LTI frequency to MVI's per million KM driven



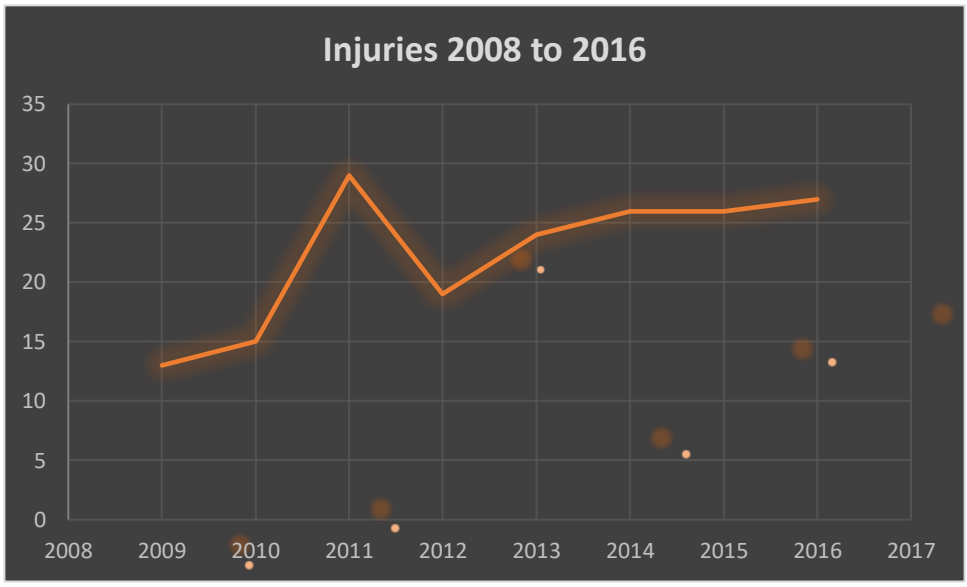
5.3.4- Total MVI injuries

Figure 5.12 below details trends in total injuries, that is lost time and non-lost time injuries combined, arising from MVI's. The graph shows a sharp increase in injuries between 2009 and 2011. This is then followed by a decrease between 2011 and 2012, after which the figure

again rises. The pattern of injuries is similar to that of the MVI rate up until 2012. However, after 2012 while the overall injury rate increases along with the overall MVI rate, it is noticeable that the LTI rate decreases. This would suggest that the actual severity of injuries is decreasing as many are not considered LTIs.

Both the overall worksite and MVI LTIs are presenting a positive downwards trend. Comparing the MVI trend and the motor vehicle LTIs, both are downward, however the LTI rate remains consistently lower. The total motor vehicle injury numbers presented in Figure 5.12 can encompass an element of randomness since the number of occupants in a vehicle can vary dramatically due to operational reasons.

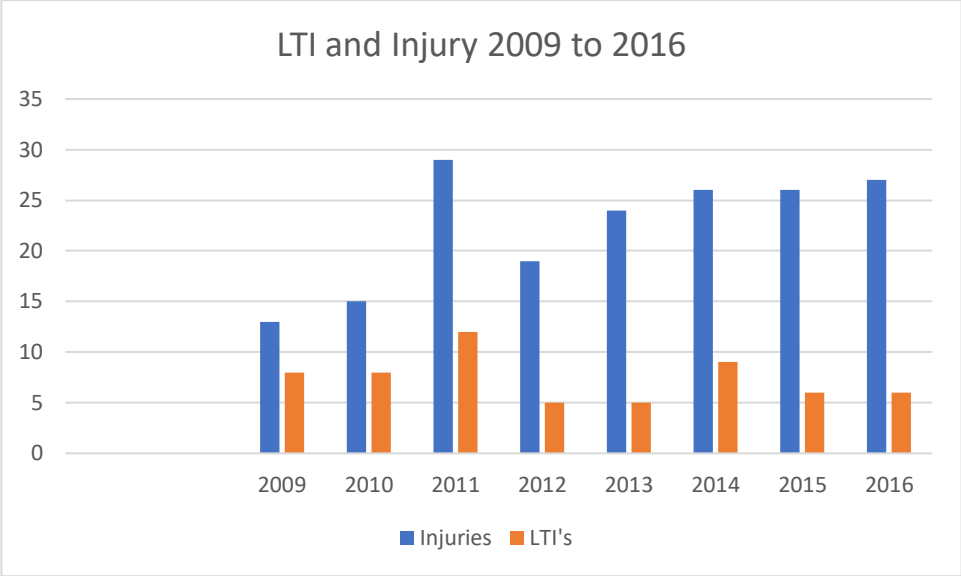
Figure 5.12 – MVI injuries 2008 to 2016



This argument is reinforced by the data provided in Figure 5.13 below. Thus, these show that no consistent pattern exists in the relationship between LTI's and the all injury figures, therefore providing further evidence that there is an element of randomness in terms of the

total injury figure. In addition, while there may be multiple minor injuries recorded in a single MVI, none of these may not result in any lost time. Therefore, it is argued that the MVI and LTI rates represent better performance indicators.

Figure 5.13 – Comparison of LTI and injury 2009 to 2016



5.4- Operational indicators

To help understand this section a short explanation is first needed of the defect management and consequences systems used within PDO operations. PDO categorises defects into four different types: A, B, C and D. Class A covers five safety critical areas, class B covers the remaining mechanical defects, class C encompasses various forms of unsatisfactory behaviour and class D relates to different types of documentary failures. The mechanisms for dealing with all defects are through non-compliance reports (NCR) and lifesaving rule violations (LSR). For more serious road safety rule violations involving speeding, using mobile phone while driving, non-wearing of safety belt, driving under the influence and not using a journey plan, the LSR consequence matrix is applied. All other violations, usually

less serious, are managed through the NCR consequence matrix. All of which are described in more detail below. Both NCRs and LSRs, along with the four types of defects, can therefore be viewed to constitute performance indicators for the purposes of the analysis that follows.

5.4.1- A Defects

Class A defects, first introduced in 2009, are considered to be the most serious. They focus on five safety critical issues. The first relates to seat belts and, more particularly, whether they are fitted properly, are of the correct type, are in good working order, and are present in the right number. It is important to point out that the non-wearing of seat belts is dealt with separately under the LSRs. The second issue relates to dangerous and defective tyres. The third concerns the presence of a rollover protection system i.e. rollover cages. The fourth issue relates to the vehicle having IVMS fitted and working. The final area relates to load security and restraint, ensuring the correct type of restraints are used in accordance with the requirements of SP2001. Where an A type defect is identified, a heavy fine will be imposed and the vehicle will be impounded by the RSST and escorted to the nearest workshop. The vehicle will not be permitted to leave the workshop until all defects have been rectified. In some cases, class A defects can be downgraded from an LSR to an NCR, depending on the particular circumstances.

Figure 5.14 – A defects 2010 to 2016

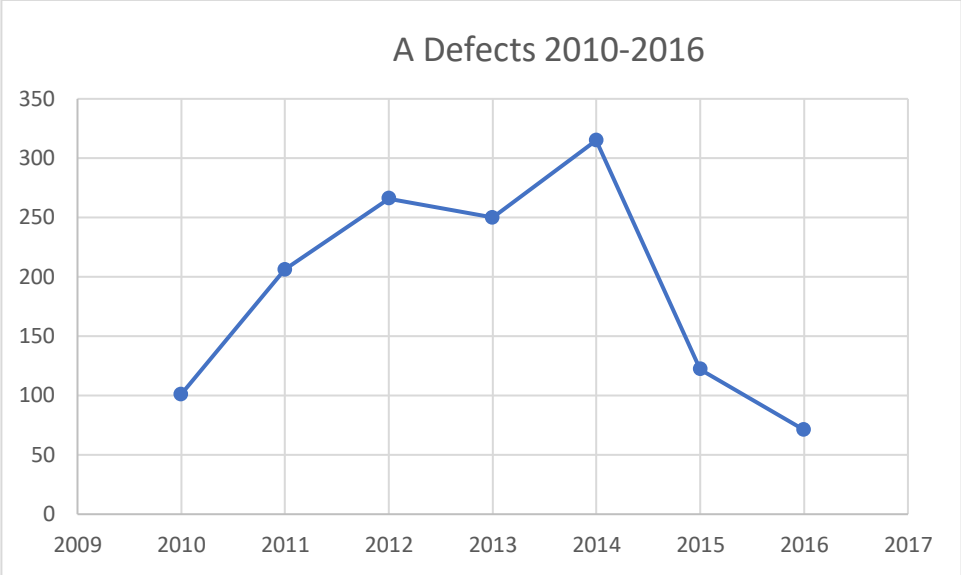


Figure 5.14 above shows that there has been an overall downward trend in A defects since 2014. Initially there was a dramatic increase in the number of violations after the initiative was first introduced until 2012, then a slight decrease in 2013. From 2013 to 2014 the numbers begin to rise, peaking in 2014. Following the Arab spring of 2011 enforcement was scaled back for most of 2011, so as not to further increase tension, however the number of reported A defects continued to rise. In 2014 some further proactive interventions, which are discussed below, were introduced and these can perhaps explain the continuous downward trend since then.

5.4.2 B Defects

Class B defects relate to less severe issues, such as cracked windscreen or mirrors, lights not working properly, faulty air conditioning, speed limiter not working, inadequate spare tyres, and high intensity rear lights not fitted or working. Vehicles found with B defects are not impounded or fined, but must have the defect remedied immediately upon returning to their base. Evidence that the defect has been rectified is sent to the concerned RSST, where

it is recorded, and no further action is taken. Should the contractor fail to evidence that the vehicle has been repaired, the RSST will then change the original B defect to a Non-Compliance Report (NCR). The NCR is then sent to PDO for further action.

Figure 5.15 – B defects 2010 to 2016

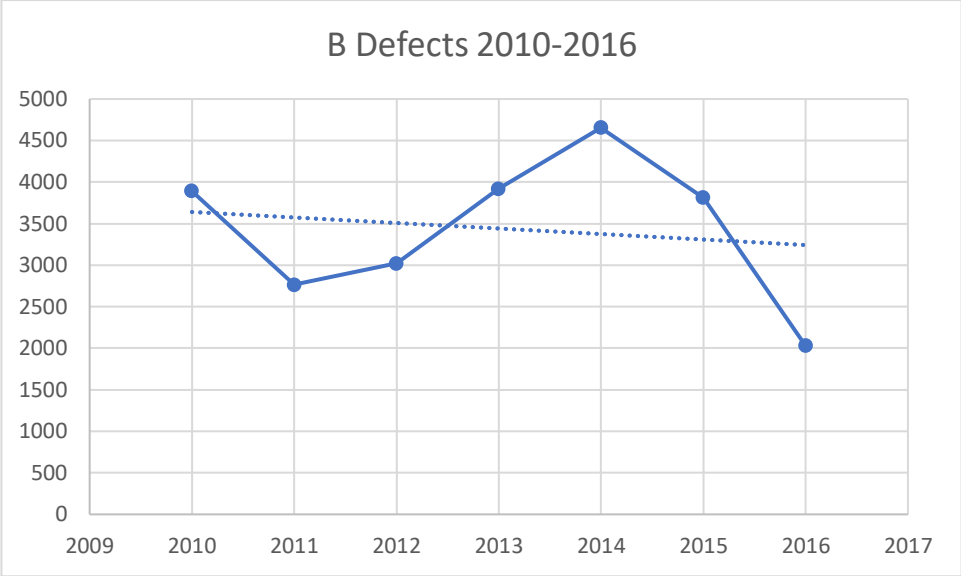


Figure 5.15 above shows an overall downward trend in B defects between 2009 and 2016. The pattern reveals similarities to that for A defects shown in Figure 5.15 above. However there appears to have been a much sharper rise in the number of such defects between 2011 and 2014. This perhaps reflects the fact that the consequences for B defects were not as severe as A defects. Similarly, the subsequent downward trend is likely to have been associated with the same proactive interventions that are likely to have influenced the reduction in A defects already discussed.

5.4.3- C Defects

Class C defects refer to non-compliant forms of driver behaviour. The main forms of these behaviours are the incorrect wearing of seat belts, speeding, using a mobile phone while driving, driving impaired, not following a journey plan or other observed risky driving behaviour, such as dangerous overtaking, not stopping at junctions and wrong lane position. The severity of the violation will determine whether a verbal warning will be given to the driver, or it will be recorded as an LSR or NCR violation. All LSR's are considered serious and follow a consequence matrix. The trend of Class C defects can be seen to follow those for NCRs and LSRs, discussed further below.

5.4.4- D Defects

Class D defects refer to non-compliance associated with procedures. Some of the main violations include vehicles found with expired Roadworthiness Assurance Standard (RAS) stickers, water tankers found with no health certificate or centre of gravity certificate, and chemical tankers found without a SHOC (Safe Handling of Chemicals) card. The same procedure applies to D defects as B ones. The contractor is given time to produce the documentation otherwise the violation is recorded as an NCR and forwarded to PDO for action.

Figure 5.16 – D defects 2010 to 2016

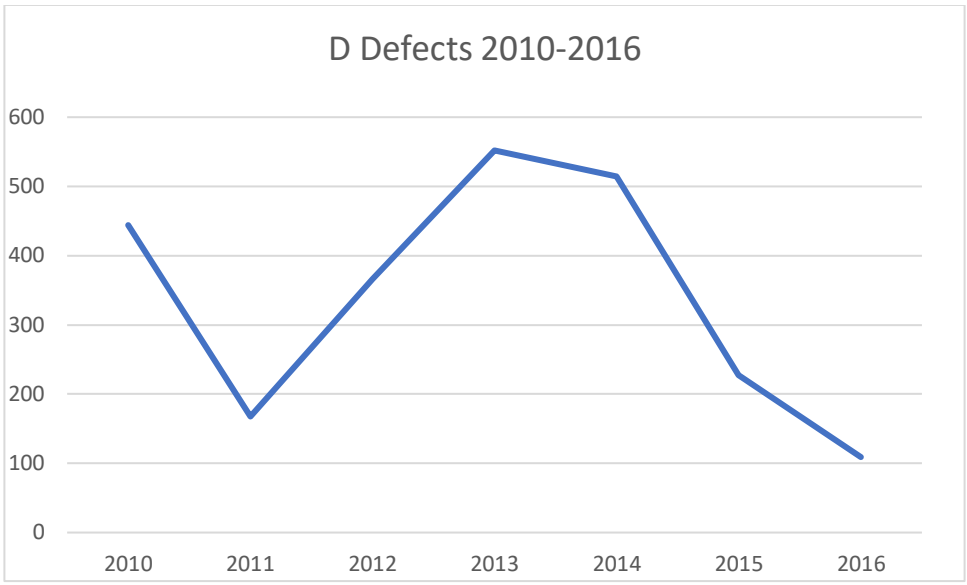
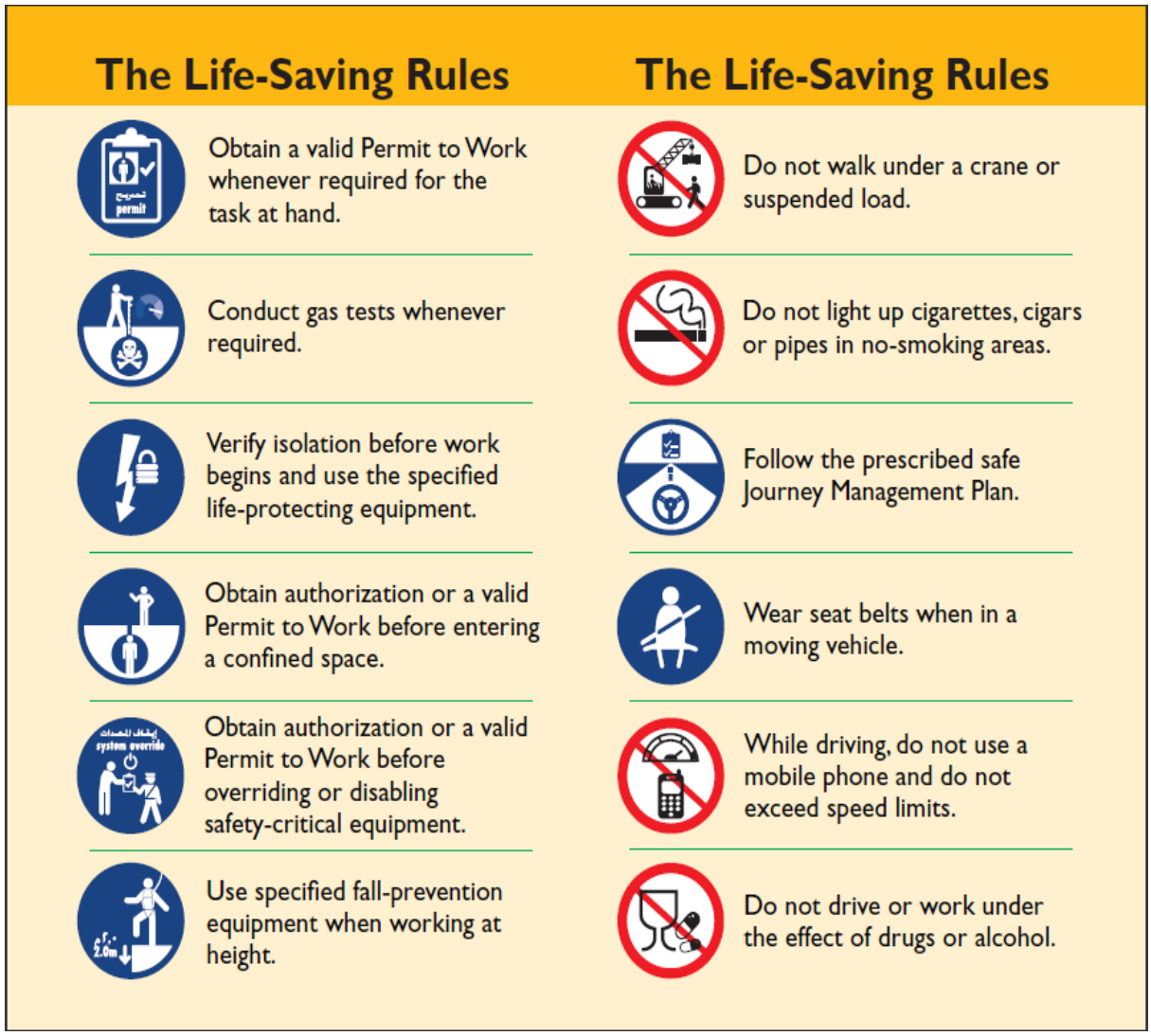


Figure 5.16 presents the overall trend of D defects between 2010 and 2016. It is clear from the graph that the number of violations has dramatically decreased since 2010. However, between 2011 and 2013 the number of violations increased to levels above 2010. Similarly, to A, B and C defects, the level of violations then decreased dramatically after 2014. This again could possibly be associated with the same interventions that positively impacted on the A and B defects.

5.4.5- Life saving Rules (LSR) and Non-Compliance Reports (NCR)

LSRs were first introduced in 2009 and comprise of twelve safety rules, discussed in more detail in chapter 4, that apply across the entire PDO operation. Five of these LSRs apply directly to driving - always obeying the speed limit, never driving under the influence of drugs or alcohol, always wearing a seat belt, always following the journey plan and never using a mobile phone while driving (table 5.1). Along with the LSRs, came the consequence matrix (discussed further below) that is applied to violations. Some of these violations can result in immediate dismissal. As discussed above, the initial violations are recorded as C defects, then, depending on the severity and circumstances, changed to an LSR.

Table 5.1 PDO Life-Saving Rules



NCR's as mentioned above are non-compliances first recorded as A, B or D defects. If the violations concerned are not then remedied, or are considered severe, they subsequently are recorded as an NCR. The NCR's are recorded in the PDO data base and are then used to assess the compliance record of contractors.

[1]PDO has in place average KPI's to monitor the reporting of MVIs and other HSE incidents. In addition, all contractor HSE systems are designed to record and report all MVIs, these systems are subject to PDO and third party auditing. There is in place in PDO a non-blame safety culture which encourages reporting, non-reporting of MVIs results in contractors facing extremely heavy fines and possible contract termination. In addition, as per the law the scene of all MVIs must attended by the ROP whom in turn prepare a report. Without the ROP report, vehicle repair workshops cannot legally accept vehicle for repair. A further barrier is the fact all the PDO clinic throughout the interior must report cases where patients presented injuries that could be associated with MVIs, or face the heavy fines for non-reporting. With all these barriers in place it makes under-reporting difficult it could be said confidently that contractors generally do accurately report MVIs.

Figures 5.17 and 5.18 below present the trends in NCRs and LSRs over the period 2010-2016.

Figure 5.17 – NCR's 2010 to 2016

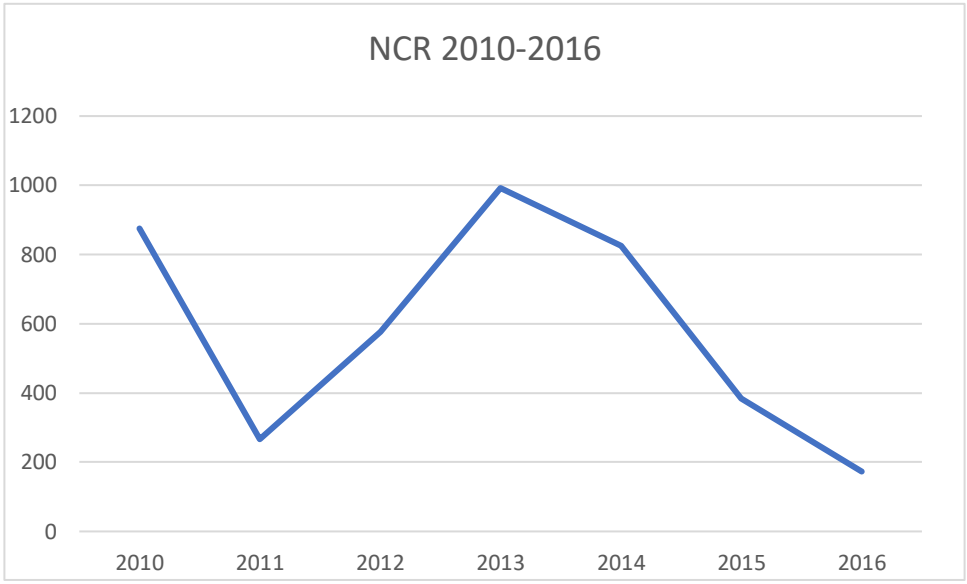
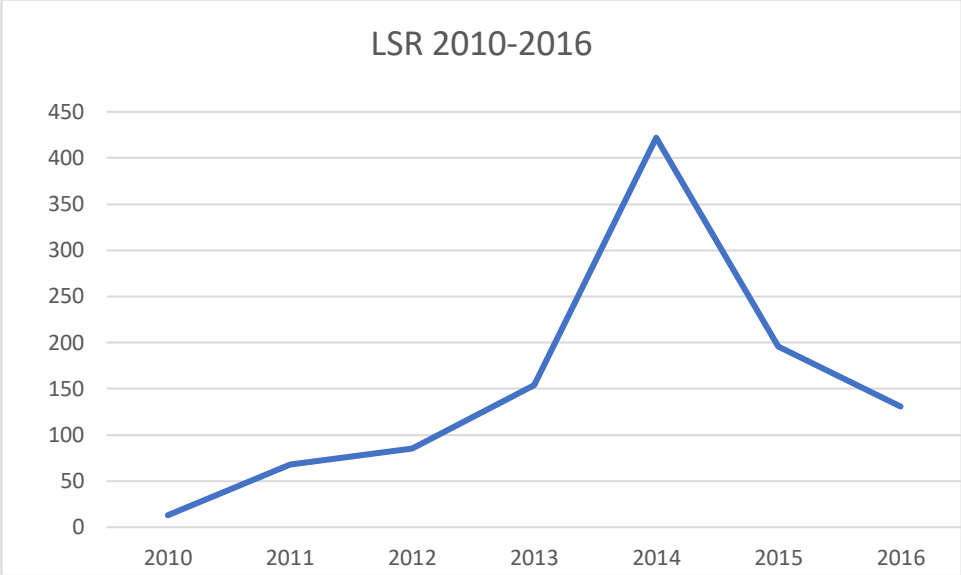


Figure 5.18 – LSR's 2010 to 2016



The trends of LSRs and NCRs appear to be following a similar pattern. The overall trend of NCR's is downward although there are fluctuations. The first sharp downward trend in NCRs between 2010 and 2011 was followed by a sharp increase between 2011 and 2013, before a continuous decline from 2014 onwards. A variety of reasons for the fluctuations are discussed further below.

The LSR trend is slightly different in that there were a higher number of LSRs in 2016 than in 2010. It is important to point out certain road safety violations changed from being recorded as NCRs to LSRs after their introduction in 2009, mainly due to their seriousness and potential to cause harm. These violations include speeding, non-wearing of seat belts, driving under the influence of drugs or alcohol, using a mobile phone while driving and not following a journey plan, and subsequently follow a more severe consequence matrix.

5.5- Factors influencing outcomes

In this section an attempt is made to analyse the factors that may be argued to have influenced the positive change in the road safety performance of PDO through three lines of analysis. Firstly, the examination of associations existing between types of violations and relevant causes of MVIs. Secondly the exploration of the impacts of particular safety related initiatives, and finally an investigation of how far an increasing reliance on driving by sub-contractor staff and self-employed drivers appears to be having and adverse impact of safety performance.

5.5.1- Trends in operational indicators and performance outcomes

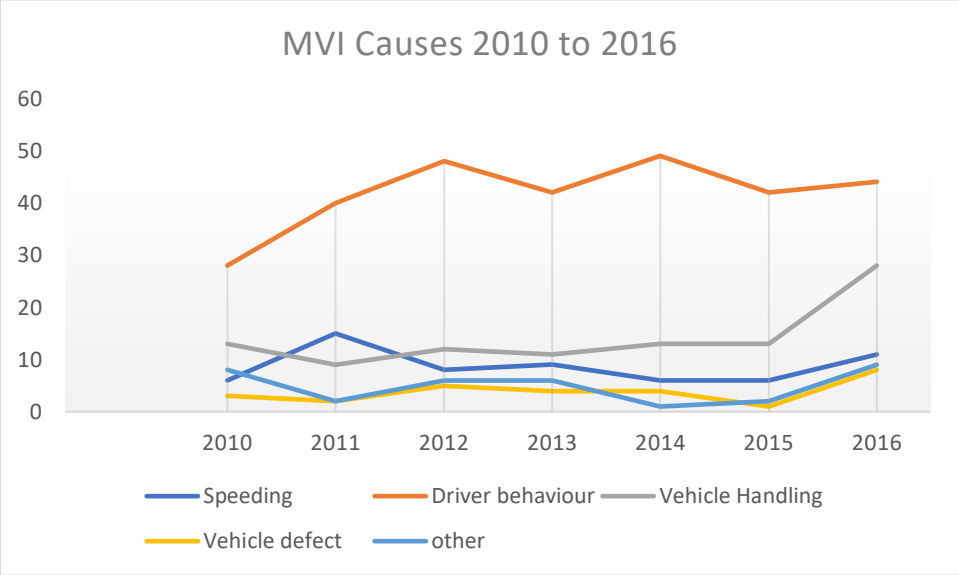
The issues forming the focus of recorded Defects, LSRs and NCRs can be seen to represent those elements of road safety that are prioritised by PDO in its road management strategies and policies. One way of assessing the influence of PDOs road safety management infrastructure is therefore to examine how far trends in these operational indicators are associated with related trends in the identified causes of MVIs. What follows provides such an examination. However, before embarking on this task some words need to be said about the nature of the data PDO compiles on the causes of accidents.

The data related to MVI causes is captured by the RSST from investigations. The RSST investigations for the most part focus on the MVI scene, using all the various markings (brake, skid, scrapes etc.), the debris fields, vehicle final resting position and mechanical condition, and road and weather conditions to scientifically determine the cause of the MVI. Other data gathered as part of the MVI investigation, when available, includes IVMS reports, driver and passenger statements/interviews, drivers' documents, journey plan and vehicle inspection reports.

As highlighted in the literature review, Haddon (1972) has argued that investigations of motor accidents should focus attention on the three elements of the driver, the vehicle and the environment and encompass the pre-crash, crash and post-crash phases of an accident. However, RSST MVI investigations are not as wide-ranging as this. For a variety of reasons, legal and contractual, RSST may not have access to much of the pre-crash data such as the driver's rest cycle, driving habits and mobile phone records. In the post-crash phase, it may also face challenges in obtaining interviews with drivers and passengers and IVMS records. Furthermore, and more generally, RSST MVI investigations do not include any organisational influence that may have contributed to the MVI, such as time pressures, fatigue and distraction. As a result, RSST investigations tend to identify 'immediate' accident causes rather than more distant organisational ones. This limitation should be borne in mind when reading what follows.

Figure 5.19 below presents the trend in main causes of MVIs over the period 2010 to 2016.

Figure 5.19: Trend in main MVI causes 2010 to 2016



5.5.2- Trends in violations and MVI causes

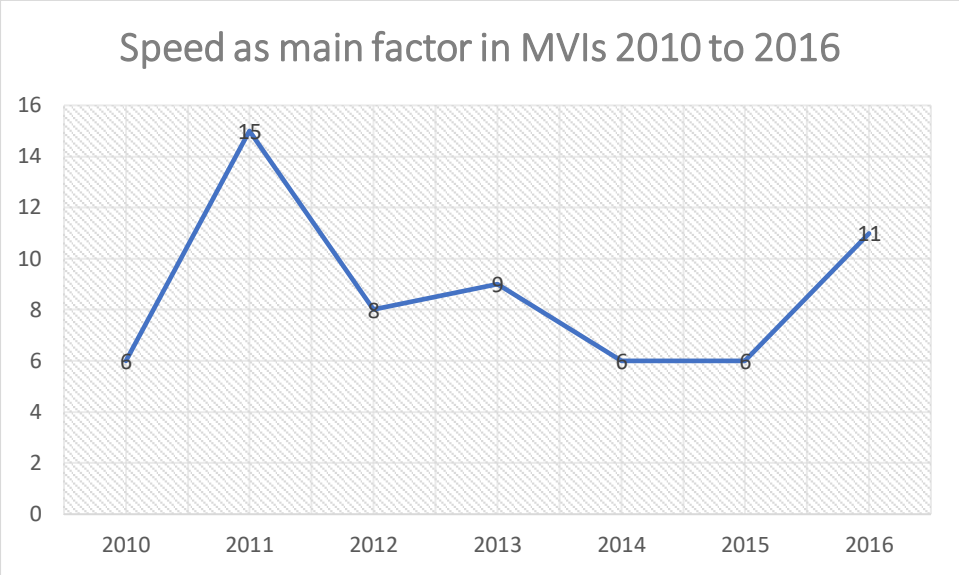
This section analyses how the trends in operational indicators are associated with corresponding trends in particular trends in MVI causes. The violations explored include, speeding, mobile phone use, not using Safe Journey Management (SJM), risky driving behaviour (not stopping at junctions dangerous overtaking, not keeping safe distance, incorrect lane position) and vehicle defects. Speeding, driver behaviour (combines mobile phone and dangerous driving) and vehicle defect are the main identified factors in PDO work-related MVIs as determined by RSST on-scene investigation reports. The quantitative data will at times be supplemented by findings from the programme of interviews conducted that will be explored more fully in the next chapter.

These trends will be compared with trends in operational indicators to identify possible associations. The quantitative data will at times be supplemented by findings from the programme of interviews conducted that will be explored more fully in the next chapter.

5.5.2.1- Trends in speeding violations and MVI cause

Speeding in terms of MVI investigations is determined as not just breaking the speed limit, but also the inappropriate use of speed, i.e. driving too fast for the conditions at the time. Figure 5.20 below presents the trend of speed as a cause in MVIs from 2010 to 2016. From 2010 to 2011 there is a negative upwards trend, from there it falls positively until 2016 where it rises negatively again. Comparing this trend in MVI causes to the speeding violation trends of LSR and NCR for the same period, some interesting similarities emerge.

Figure 5.20: Speed as a main factor in MVIs 2010 to 2016



To clarify the distinction between LSR and NCR speeding violations, the former relates to speeds 20 km/h over the limit, while the later relates to speeds of between 10 and 20km/h over the speed limit, for 30 consecutive second, as detected by IVMS or the RSST.

Figure 5.21 below presents the NCR speeding violations between 2010 and 2016. The overall trend is positive, however the period between 2010 and 2013 shows a very dramatic positive improvement. From 2013 onwards, the trend follows a similar pattern to that of speed as a main factor in MVIs.

Figure 5.21: NCR speed violations 2010 to 2016

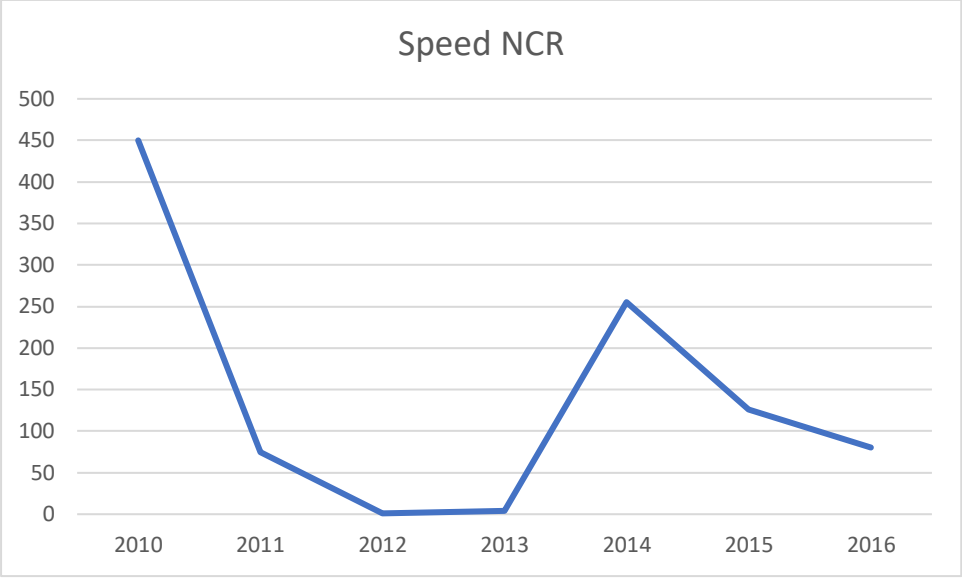


Figure 5.22 below meanwhile presents the trend in LSRs related to speeding between 2010 and 2016. The trend presents a negative trend in violations between 2010 and 2014, and, thereafter, a continuous positive one. The LSR speed trend follows a similar pattern to the MVI speeding trend, as well as the NCR speed violation one, from 2014 onwards.

Figure 5.22: LSRs: Speeding 2010 to 2016

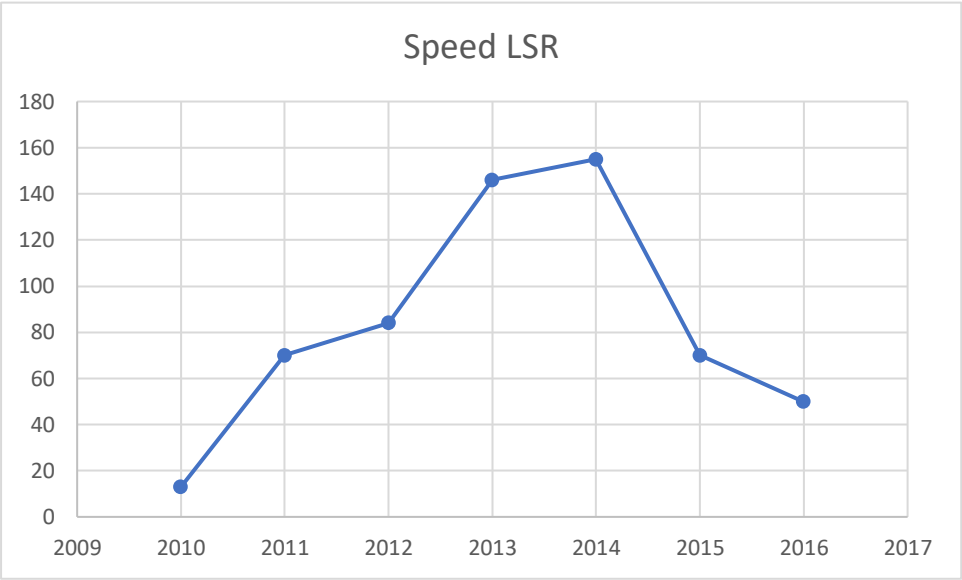
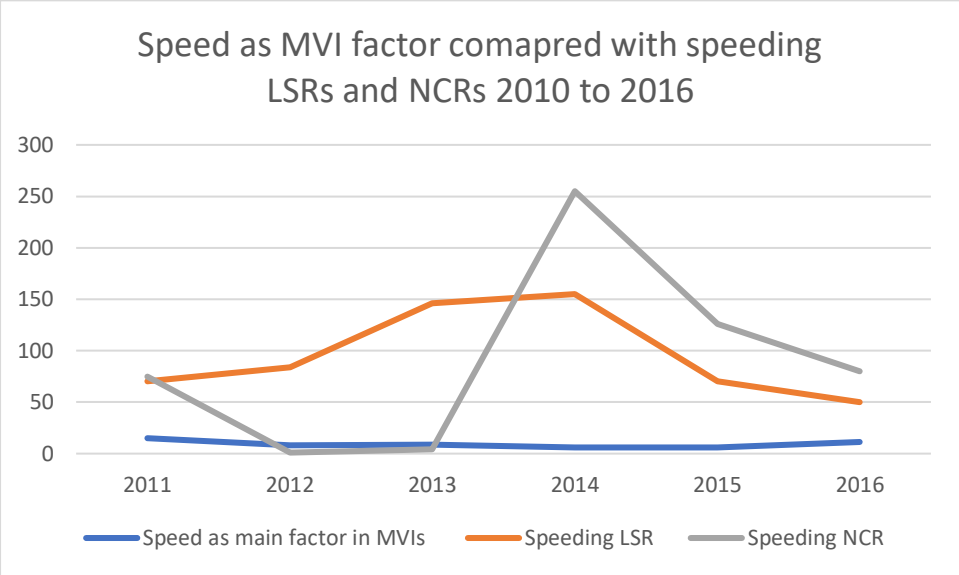


Figure 5.23 below presents the trends in speed as a factor in MVIs, speeding LSRs and NCRs between 2010 and 2016. The trends are following a similar downward pattern from 2014 onwards. The trend further supports other operational indicators in that there is an association between positive violation trends and MVI/LSR trends.

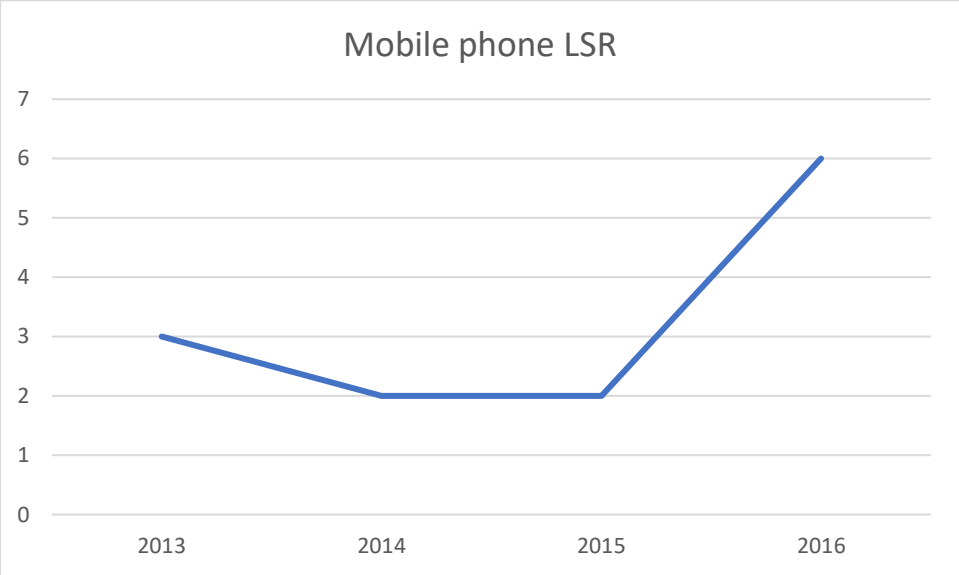
Figure 5.23: Speed as a factor in MVIs compared with trends in speeding LSRs and NCRs 2010 to 2016



5.5.2.2- Trends mobile phone use and MVI causes

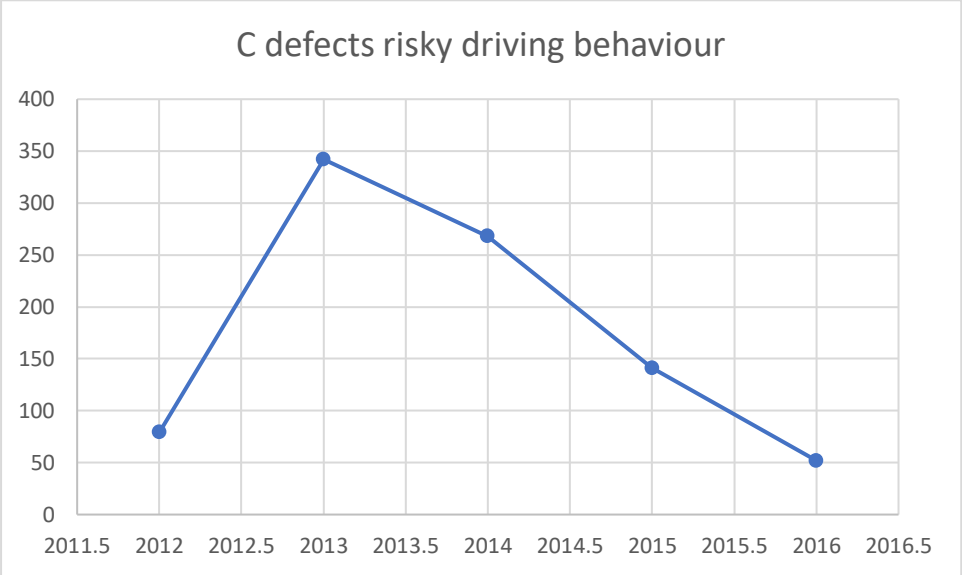
Figure 5.24 below presents the numbers of LSR violations for using a mobile phone while driving between 2013 and 2016. Although the numbers are small, they nevertheless show a negative upward trend on violations, which is in contrast to the other LSR violations. The qualitative data collected suggests strongly that mobile phone usage while driving is an increasing trend further supporting the trend below. However, the trends do further support the logic that an increase in violations can be associated with and increasing MVIs.

Figure 5.24: Mobile phone LSR violation



To add further to this figure 5.25 below presents the trend in C defects related to risky driver behaviour, from 2012 to 2016 including dangerous overtaking, not stopping at junctions, not keeping as safe distance and incorrect lane position. The trend is again similar to the previous ones in that it presents a negative trend in violations up to 2013, after which a positive downward trend is evident. The trend is again further supporting the association between less violations and decreased MVIs and vice versa, highlight improved driving behaviour.

Figure 5.25: C defects for risky driving behaviour



Driver behaviour is by far the largest cause of MVIs in PDO operations. This includes use of mobile phone along with other dangerous driving behaviours such as, not stopping or giving way to other traffic, dangerous overtaking, not keeping in the correct lane. Figure 5.26 below presents the trend in driver behaviour from 2010 to 2016. The overall trend is negatively upward, with periods of very minor improvement and deterioration. When looking at the trend in driver behaviour as a main factor in MVIs and some behavioural LSR and C defect violations, some interesting comparisons emerge. Firstly, the trend of driver behaviour as a main factor in MVIs, (see Figure 5.26 below), compared with the trend of LSR violations for mobile phone use (see Figure 5.24), follow a similar negative upward trend.

Figure 5.26: Driver behaviour as main factor in MVIs

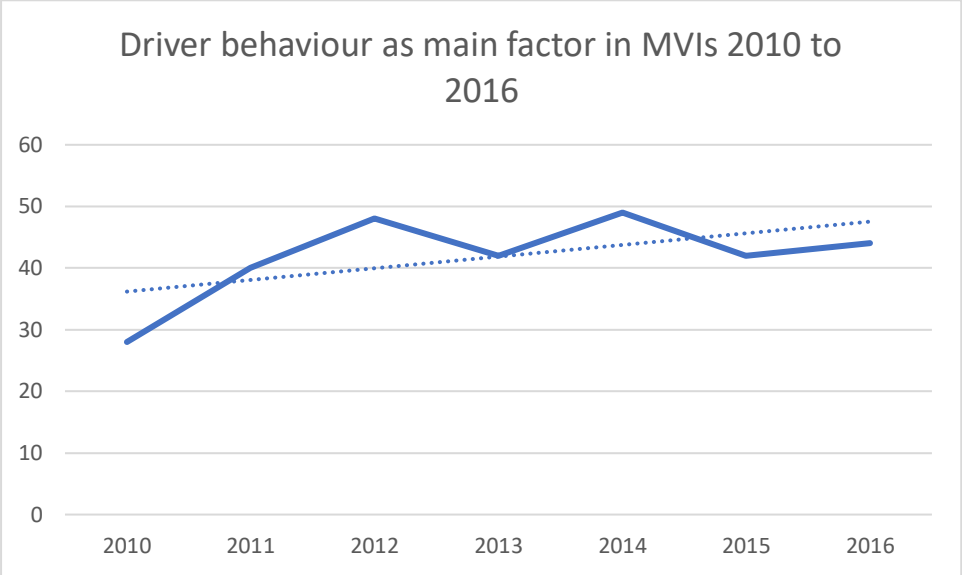
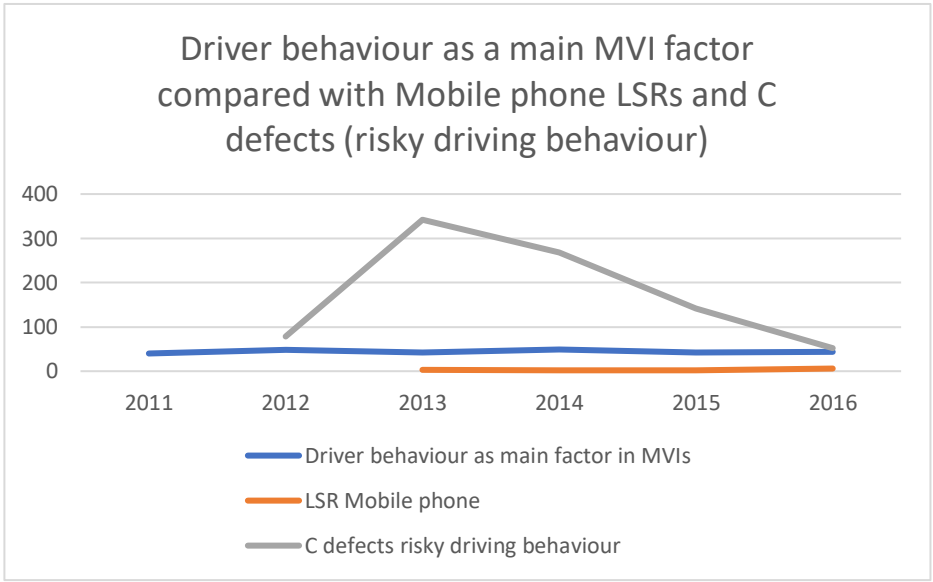


Figure 5.27 below present a comparison between driver behaviour as an MVI factor and mobile phone LSRs and C defects for risky driving behaviour. Driver behaviour as a main factor in MVIs like mobile phone LSRs and C defects follows a negative upward trend.

Figure 5.27: Driver behaviour as a main MVI factor compared with and mobile phone LSRs and C defects (risky driving behaviour) 2010 to 2016



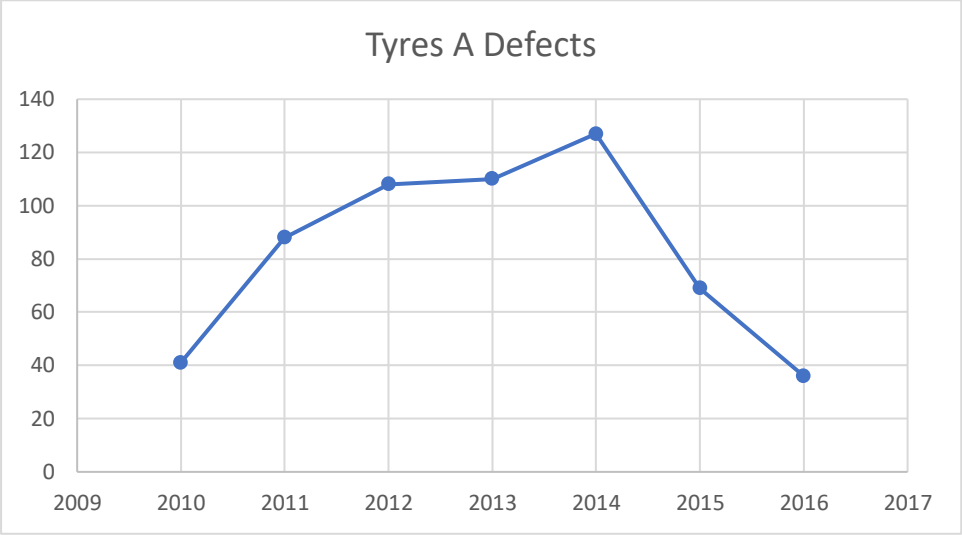
What the data does not tell us is what is causing some of these negative behaviours among drivers. The qualitative data collected suggest organisational, personal and cultural influences are influencing the trend in these behaviours. Among those identified in the qualitative data driver fatigue and distraction appear to be the leading causes. The behaviour trend does not follow the majority of positive trends with the operational indicators and performance outcomes. This suggests that there is improvement in some areas of driver behaviour, however further improvement is needed in others. However, the trends both positive and negative do support the logic that increases and decreases in violations corresponds with the same in MVI trends.

5.5.2.3- A defects and trends in vehicle defects as a cause of MVIs

Comparing the trend in vehicle defects violation trend to that of defects as a cause of MVIs, some similarities emerge. We compared two defects that could cause an MVI, namely tyres and load security.

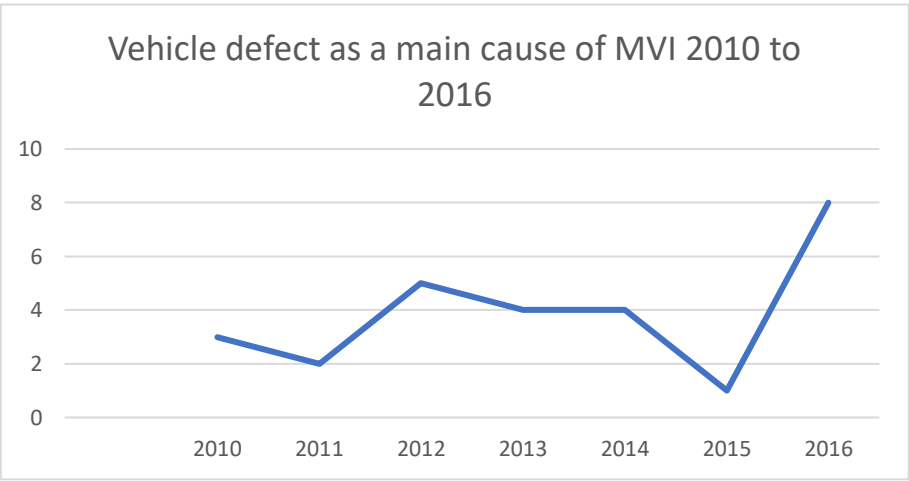
Tyres are again another safety critical component of PDO road safety. Looking at figure 5.28 below we can see that the trend from the period between 2010 to 2014 was negative, however from the period 2014 to 2016 a dramatic positive trend is presented. When compared to the MVI trend for the same period a similar trend can be seen. Similarly, both the trends of defects as a cause of MVI and tyre A defects follow a similar pattern with the exception of 2016. These trends further support the possibility that lower defects number are associated with lower numbers of MVIs and vice versa.

Figure 5.28- A defects: Tyres



Vehicle defects accounts for 5% as a main factor in all PDO work related MVIs, and as mentioned previously involves at least one other factor. Figure 5.29 below presents the trend for vehicle defect as the main cause of MVIs between 2010 and 2016. The trend itself is up and down, what is interesting is the trend follows a similar pattern to that of the MVIs for the same period. However, it follows the same pattern as other operational indicators, with the exception of 2016.

Figure 5.29: Vehicle defects as a main cause of MVI



Load security is another PDO A defect which could potentially be an MVI causational factor. As can be seen below in Figure 5.30 the trend is following a similar pattern to the previously discussed tyre A defect trend, presenting a negative trend for the period 2010 to 2013, after which a positive trend occurs. The load security violation trend follows the vehicle defect as a cause of MVI trend, as well as the overall MVI trend, again supporting the logic less defects represents less MVIs.

Figure 5.30- A defects: load security

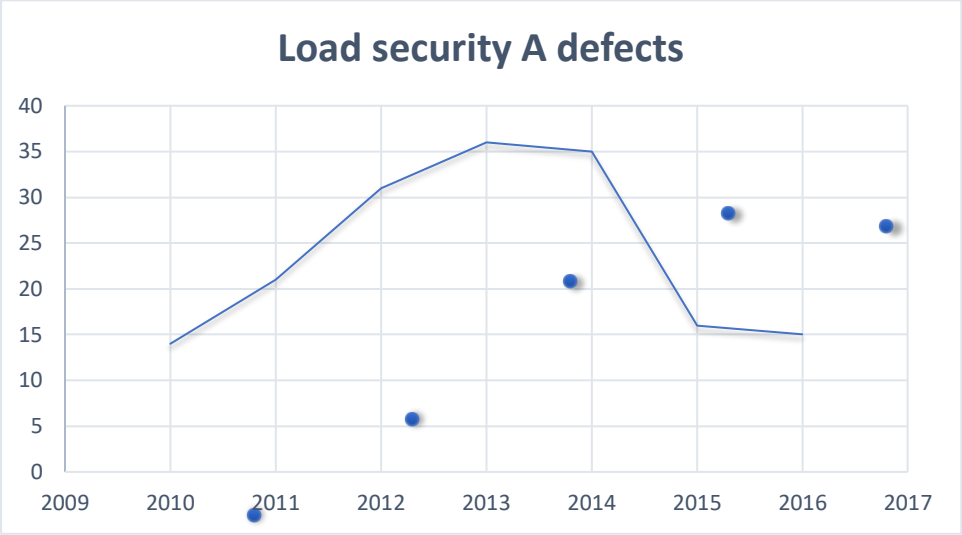


Figure 5.31 below presents the trends of vehicle defects as a main MVI cause with tyre and load security A defects. Both the tyre and load security A defect trends follow a similar positive downward trend, while vehicle defects as an MVI cause follows a positive trend with the exception of 2016. These trends would stand to further strengthen the logic that lower defects can be associated with lower numbers of MVIs.

Figure 5.31- Vehicle defects as an MVI cause compared with tyre and load security A defects

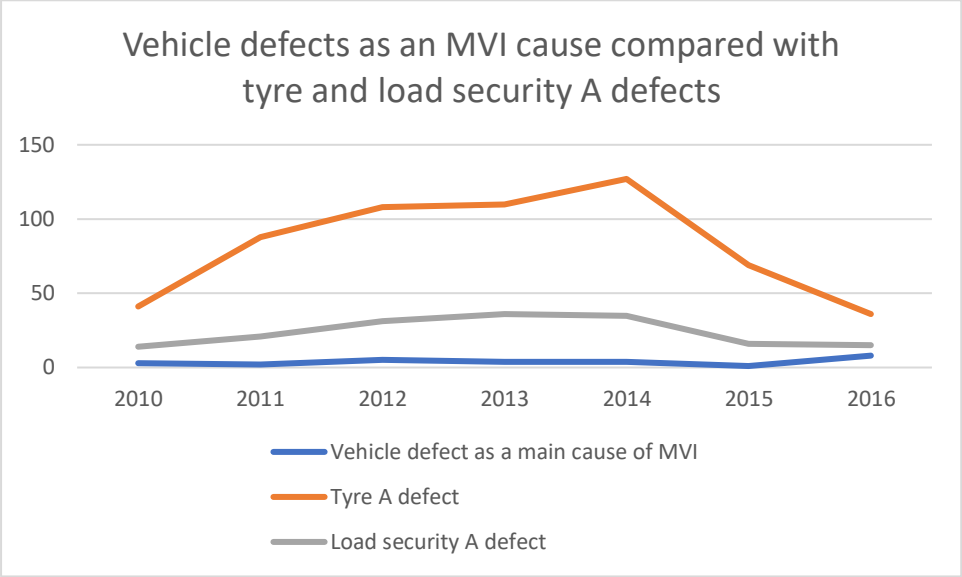
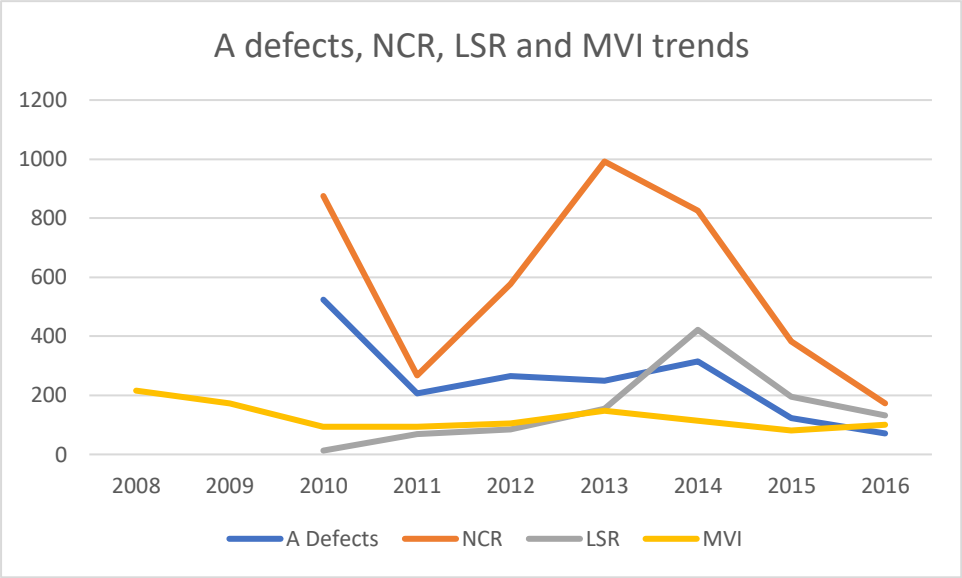


Figure 5.32: A defects, NCR, LSR and MVI trends



When comparing the MVI causes with some of the violations some interesting patterns emerge. In general, where decreases in violations occurred, this corresponded with decreases in MVIs. Figure 5.32 above presents A defects, LSR, NCR and MVI trends. What is clear is they all broadly follow a similar pattern, particularly from 2014 onwards there is

a positive downwards trend in violations which corresponds to the same positive trend in MVIs, supporting the logic less violations lead to less MVIs.

5.5.3- Influence of road safety interventions

In what follows attention is paid in turn to four different types of interventions: IVMS, hearts and minds campaigns, defensive driving, and enforcement measures by the RSSB, and their possible impact.

5.5.3.1- In Vehicle Monitoring System (IVMS)

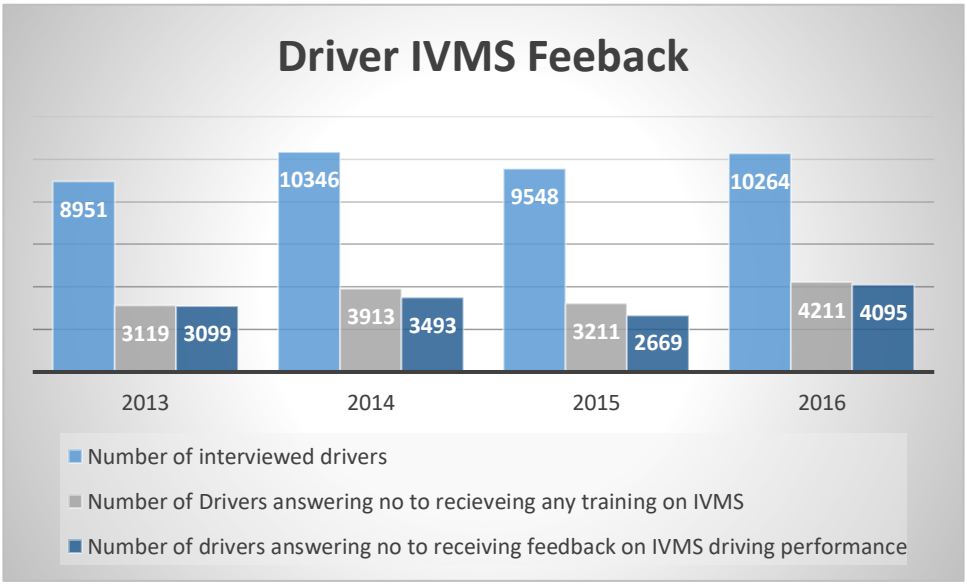
The IVMS requirement came into effect for all new PDO contracts in 2008. It represented the first use of technology to monitor driver behaviour among PDO and contractors. The rationale behind the implementation of IVMS was to alert management of adverse driving behaviour and enable them to intervene immediately, possibly avoiding an MVI. It was also intended to highlight positive driving behaviour, for which a reward system was put in place. Due to the nature of operations, staff often find themselves in remote desert areas, which is why vehicles fitted with IVMS have a panic button which when triggered transmits a signal giving the vehicle location.

A sharp drop in the MVI accident rate can be seen after the initial implementation of IVMS in 2008 and again when it was re-energised in 2013. This would on the face of it suggest that drivers improved their driving against the background of it being monitored. In reality, there are grounds to believe that contractors were not monitoring their drivers and vehicles, possibly due to a lack of knowledge in relation to the functionality of IVMS. Thus, reports from audits conducted by the RSST between 2008 and 2013 confirmed that most contractors had complied with the installation of the system but that the system was not being used as

intended. However, following re-energisation in 2013 Figure information received by the RSST from drivers over the period 2013-2016 indicates that the numbers receiving feedback on their driving performance had been increasing (see Figure 5.33 below). It therefore seems likely that drivers are now more aware of the elements of driving, such as speeding, harsh braking, non-wearing of seat belt, that the IVMS system could detect.

Looking further at the trends in LSRs for both speeding and non-wearing of seat belts discussed above, it is evident that after 2013 a clear reduction in violations occurs. This corresponds to the increased numbers of drivers receiving feedback. This is further supported by the qualitative data from the interviews reported in the next chapter which finds that IVMS has been one of the greatest influencers on driving behaviour.

Figure 5.33 – Driver IVMS feedback data



5.5.3.2- Hearts and Minds

During the period 2014 to 2016, PDO rolled out hearts and minds campaigns not only to its contractors but the general population. The hearts and minds campaigns were targeted at particular road safety issues, with the aim to influence positive change. Campaigns during this period have, in particular, included ones focused on rollovers and seat belts, driving behaviour, tyre conditions and seat belt wearing. These messages were rolled out through various internal campaigns, as well as a PDO sponsored campaign aimed at the general population which included TV advertisements and a presence at relevant public events. In this section we will discuss each of these campaigns and their impact on PDO road safety.

5.5.3.2.1- Rollover simulators and Seat Belt convincers

The rollover and seat belt simulation campaign has been ongoing since 2005 but was re-energised as a campaign in 2013. The seat belt simulation equipment, known as a 'seat belt convincer', simulates an impact of 7 km/h to demonstrate how the seat belt protects drivers, even at low speeds. The rollover simulation equipment consists of a full-size car on a frame that can complete a 360-degree rollover with the participants inside. The simulation again demonstrates the importance of wearing the seat belt as well as experiencing the sensation of a rollover. This campaign was delivered by the RSST visiting all work locations and camps to ensure all staff and contractors had the opportunity to avail themselves of the experience of using the equipment. The period after this campaign saw a reduction of LSR violations related to seat belt wearing, from 64 in 2013 to 27 in 2016.

5.5.3.2.2- Driving Forums

Driving forums were first introduced in 2009 and re-energised in 2013 to focus on driver behaviour. The forums are led by the MSE7 corporate road safety team and are facilitated

by PDO directors. These are interactive sessions covering all driving related issues. The forums are firstly socratic educational sessions focusing on driving related issues. During them open discussions take place in which drivers can raise issues or questions related to driving and road safety. Feedback on the difficulties and challenges faced by the drivers is communicated to the directors, and subsequent action taken on relevant points. Some examples of the actions resulting from these sessions include improved road maintenance, new driver rest facilities and better planning of loading and unloading, thus reducing waiting time for drivers. Furthermore, drivers following set criteria that demonstrate good driving behaviour are nominated and receive awards.

It is difficult to link the work of the driving forums to particular performance outcomes. However, as highlighted in the literature review, group discussions as an intervention have been shown to have a positive impact on road safety. Logic would also suggest that they may well have had some impact on the positive trends in LSRs related to seat belt wearing, journey planning and speeding. The main aim of the forums is to improve driver behaviour. The improvement particularly in speeding, seat belt wearing and journey management LSRs would suggest that they may well have had a such a positive impact.

5.5.3.2.3- Tyre safety campaign

Tyre safety has always been a priority in PDO operations. In 2014 the tyre safety campaigns were reinvigorated following two serious MVIs where the age of tyres was the major factor. The campaign involved tyre manufacturers and the RSST visiting contractor yards to discuss tyre pressure, age, wear, tread depth, and load rating with the drivers. In 2015 PDO commissioned the TRL to conduct a tyre study on vehicles within its operation. The main findings of the study focused on two areas, one being tyre pressure, the other the temperature

rating of the tyres being used. In relation to tyre pressure it emerged generally that tyre inflation was good, however there were extremes between high and low pressure which caused concern, as this could lead to catastrophic tyre failure. The study found that 39% of the vehicles checked did not have the correct temperature rating for the Middle-Eastern environment. It also found that different standards and laws are not aligned within the region. All of these findings have now been developed into action items, and are the subject of the current tyre safety campaigns.

Again, it is difficult to reliably attribute any trends in safety performance to the type campaign. It can though be plausibly linked to the reduction in tyre A defects that has occurred from 2015 onwards. Thus, between 2009 and 2014 tyre failure was the main factor in 12 MVIs. Since the tyre study and following the campaign, in both 2015 and 2016 tyre failure was a factor in just one MVI.

5.5.3.3- Defensive Driving

In 2001 defensive driver training became compulsory for all drivers with the aim of bringing the overall driving standard in the operation to a higher standard. Courses were put in place for both black top and graded roads for all categories of vehicles.

Initially earlier defensive driving material focused more on the technical aspects of driving, and was delivered by a number of training institutes. This caused variances in the standard and quality of delivery. Having said that, Figure 5.19 above presents a positive downward trend in MVIs after its implementation in 2001. However, by 2004 the MVI rate began to present a negative upward trend, possible due to message fading.

In 2008, a significant change was made to the delivery of PDO defensive driving training and assessment structure. Through a tender process, the delivery of defensive driver training was awarded to a single training provider, with the assessment awarded to another single provider, moving to a system where training and assessment were completely separated, creating greater transparency. At the same time, the training material was changed to focus on behaviour and the course lengths were extended. In the new system once, a driver was deemed competent after an assessment, a PDO defensive driving permit was issued allowing that driver to drive in the PDO concession area.

In 2013, based on the analysis of PDO MVI's in 2012 referred to earlier which highlighted driver behaviour as the main factor in MVIs, the driver training material was changed to further focus on driver behaviour and responsibility. The new defensive driving training material therefore adopted the approach advocated by Haley (2006) in focusing on driver attitudes and behaviour.

Evidence of the possible impact of the behaviour based defensive driving can be seen in a number of ways. Firstly, as mentioned above, this training was aimed specifically at changing driver behaviour. The trends in behaviour related LSR and NCR violations began to decrease simultaneously with the trend in MVIs from 2013 onwards, this could possibly be associated in some part with defensive driving training. Secondly the assessment for the DD permit validity was based on risk, meaning higher risk drivers return for refresher training sooner than those at lower risk. This ensured that safety messages related to driving behaviour were reaching those most in need. Finally, as mentioned above, evidence from the qualitative data suggests that defensive driver training was one of the greatest influencers on PDO road safety.

5.5.3.4- Enforcement

In 2009 the new Road Safety Standards Body (RSSB) contract was tendered and subsequently awarded. The new (RSSB) now combines both the Road Safety Standards Team (RSST) and the Defensive Driving Assessments Team (DDAT), which were previously separate.

The main roles of the RSST consists of auditing, accident investigation and enforcement. The auditing function focuses on journey management, IVMS and vehicle maintenance management system (VMMS) of PDO and contractors to determine compliance with the implementation and the management of the specific policies. NCRs are raised where gaps are identified and not remedied. Enforcement consists mainly of roadside vehicle spot checks, which are twofold aimed at the compliance of both the driver and the employer. The enforcement of LSRs are aimed at the driver compliance while the A defects aim at employer compliance, both following different consequence matrices.

Another form of enforcement is through RSST visits to contractors' yards. This began as a pro-active measure in 2014, where vehicles are inspected, any defects highlighted are rectified before the vehicle goes on the road, but no fines are issued. This softer enforcement, has coincided with a marked decline in violations while the number of on road spot checks remained the same.

It would seem clear from the trends in LSRs, NCRs and A defects discussed above, that enforcement has played a role in improving compliance.

5.5.3.4.1- Consequences

As discussed in chapter 4, all of the various violations are managed through two separate consequence matrices, with varying associated penalties that are reflective of the perceived

type and severity of them. The two-specific consequence matrices related to road safety, are the LSR and NCR.

It could be argued that the LSR consequences, designed to improve individual behaviour around 12 high risk areas, have had an impact on PDO's road safety performance. As can be seen from the above, trends in violations have improved. The quantitative data cannot tell us why there has been a reduction in LSR violations. However, among the interviewees it was suggested that LSR violations apply directly to the driver and involve a significant risk of job loss. It was further suggested that both the consequences and the high probability of getting caught have led to a high level of compliance, resulting in a reduction in the number of LSR violations. Following the same logic as discussed previously, the reduction in LSR violations in particular is presenting an improvement in behaviour, positively impacting on MVI and LTI performance.

Table 5.2 – PDO Life-Saving Rules Matrix

Rule is broken for the first time	**Warning Letter** *low potential impact*	**Final Warning Letter**	**Dismissal**
	Final Warning Letter *high potential impact*		
Rule is broken for the second time *or* several rules are broken at the same time	**Final Warning Letter**	**Dismissal**	
Rule is broken for the third time, *or* rule-breaking caused injury or death, *or* was done recklessly or wilfully	**Dismissal**		

Table 5.3 below presents the general road safety consequence matrix which was in existence prior to the introduction of the LSR matrix. As mentioned above, while the more serious road safety violations are now all dealt with through the LSR consequence matrix, an overlap still exists between the two matrices.

All B, C and D defects become NCRs and the violations are addressed through the matrix below. NCRs are presented to the contractor and not the individual that has committed the violation. As discussed above, the overall trend in NCRs is positive, therefore helping explain the positive trend in outcome performance. Further to this the qualitative data gathered during the interviews suggests that the vast majority of drivers wish to comply with driving rules. It was suggested that the chance of getting caught by the RSST or through IVMS were high, bringing with it embarrassment in front of management and colleagues.

Table 5.3 – General Road Safety Consequence Matrix

Offence	First instance	Second instance	Third instance	Fourth instance
Driving under the influence of drugs or alcohol	Dismissal			
Driver or Passenger Not using the seatbelt while the vehicle is in motion	Final warning	Dismissal		
Over speeding recorded by IVMS	Final warning	Dismissal		

Using mobile phone while driving (both handheld and hands-free)	Final warning	Dismissal		
Tampering safety device	Final warning	Dismissal		
Not complying with the Journey Management Plan rules	First warning letter	Final warning	Dismissal	
Unauthorized driving for private use	First warning letter	Final warning	Dismissal	
Driving with expired ROP license and DD driving permit	Verbal Warning	First Warning	Final warning	Dismissal
Leaving ignition key and/or IVMS smart key with vehicle unattended or use of smart key of others	Verbal Warning	First Warning	Final warning	Dismissal
Any other road safety noncompliance not mentioned in the above offences	Verbal Warning	First Warning	Final warning	Dismissal

A defects are seen as much more serious and are therefore treated separately to B, C and D. The consequences of A defect violations result in a substantial fine for the contractor rather

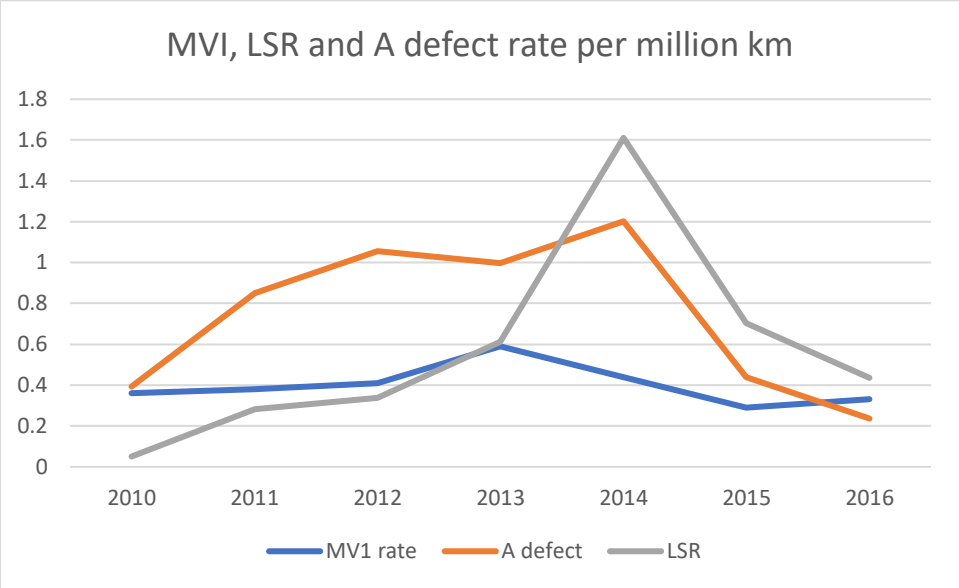
than the driver. It emerged through the qualitative data that it was generally felt that contractors after the consequences were in place for a period of time realised it was more cost effective to fix the defects rather than pay the fine, it was further suggested that the probability of getting caught by the RSST was high.

5.5.4- Composition of the contractor/sub-contractor driving population

PDO's main relationships are between their direct staff and their direct contractors. In terms of road safety PDO manages their contractors in the same way they manage their own staff. However, contractors then have relationships with sub-contractors, some of which are self-employed Oman Truck Operators (OTO's). The government is encouraging the use of OTO and local sub-contractors due to political pressures from these groups. As discussed below this trend is growing, and, as it does, the direct control PDO has over road safety reduces. This reduction in direct control clearly has potentially adverse consequences for road safety management in PDO. In this section therefore, an attempt is made to analyse how far the growth of sub-contracting is acting in this way.

The implication of this potential loss of control is explored by comparing the performance of contractors and sub-contractors. This analysis encompasses three stages. First, an assessment of the growth in sub-contractor numbers and their importance in relation to total KMs driven in the PDO area of operations. Secondly, the relative contribution that they make to reported A defects and LSRs is examined on a KM driven basis. Thirdly, the same is then done with regard to the relative contribution they make to total MVIs. Figure 5.36 below presents an overall comparison of MVI, LSR and A defect rate per million KM driven. We will now explore the contribution of contractors and sub-contractors to these rates.

Figure 5.34: MVI, LSR and A defects per million KM driven 2010 to 2016



Prior to the Arab spring in 2011 there were approximately 336 direct PDO contractors and 50 sub-contractors. In contrast, currently the contractor register shows 245 direct contractors and approximately 500 sub-contractors. This would suggest a possible tenfold increase in sub-contractor vehicles operating in the PDO, adding to the increase in KM driven from 2011. It is difficult to determine the exact number of sub-contractors vehicles operating in PDO, however it is clear this number has significantly increased since 2011, reducing the control PDO has over its road safety.

Figure 5.35 below compares the A defect rate per million KM driven between contractors and sub-contractors. Even though A defect rates follow a general downward trend, figure 5.35 below highlights a shift in violation rates from contractor to sub-contractor. Similarly, the LSR rate per million KM driven between contractors and sub-contractors is shown in Figure 5.36 following a similar pattern to that of the A defects. In particular, from 2011

onwards the shift in trend is more dramatic coinciding with the Arab spring after which began the shift from contractor to sub-contractor.

Figure 5.35: Contractor vs sub-contractor A defect rate per million KM driven 2010 to 2016

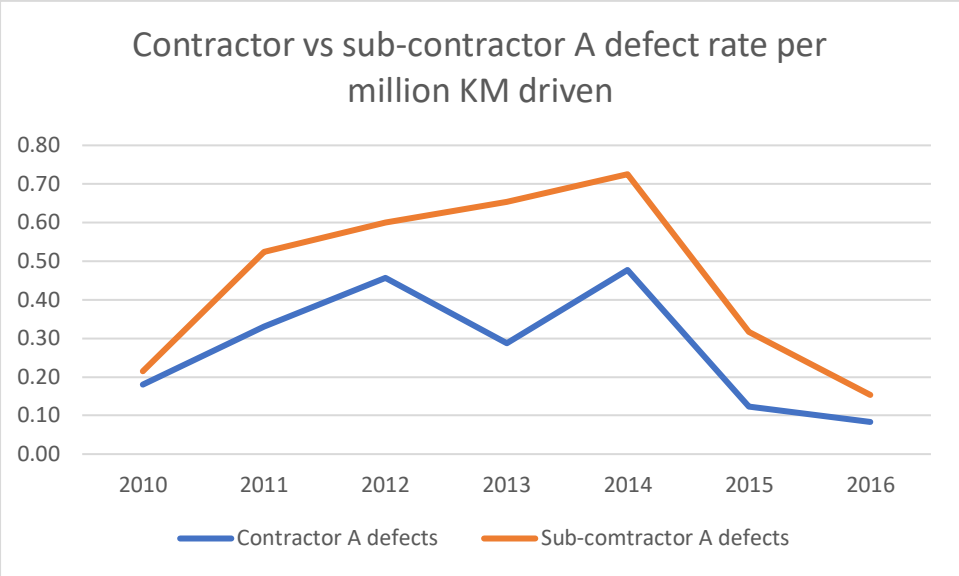
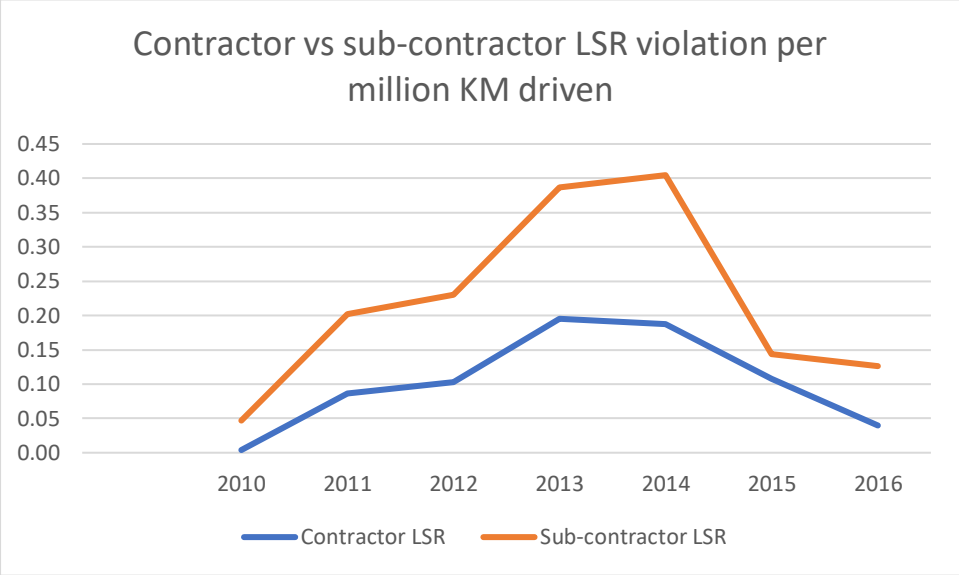
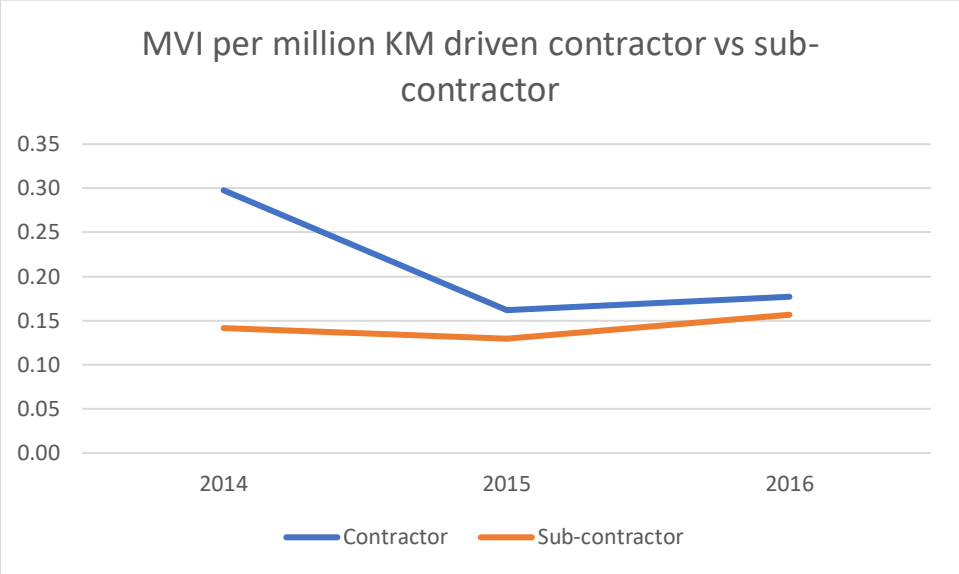


Figure 5.36: Contractor vs sub-contractor LSR rate per million KM driven 2010 to 2016



Thirdly, looking at the contribution of contractors and sub-contractors trends MVIs a further shift can be identified. Figure 5.37 below presents a comparison of the MVI rate per million KM driven between contractors and sub-contractors. Contractors still make up the largest part of the PDO population, therefore would be represented in more MVIs. However, the reduction in contractor violations as discussed above can be associated with greater compliance and increase use of sub-contractors. What we can be seen is contractor MVI trend is decreasing, whereas sub-contractor rate is increasing. This is not surprising due to the increased number of sub-contractors operating in the PDO area. However, the MVI performance of sub-contractors is better than contractors, which can be associated with population size, however violations are significantly more than contractors, which highlights compliance and management issues associated with sub-contractors.

Figure 5.37: MVI rate per million KM driven contractor vs sub-contractor



On analysing all of the above elements we could conclude by the increase in the KM driven, the shift in trends in the operational indicators and performance outcomes, that the increased

number of sub-contractors has had a negative effect of PDO road safety, and remains a challenge within PDO operations. It could be argued that the increase in sub-contractors and OTO drivers has meant that some of the improvements in contractor performance was effectively undermined by the rise in sub-contractors.

5.6- Conclusion

In this chapter we set out to analyse the road safety performance of Petroleum Development Oman (PDO), focusing on the years 2008 to 2016. The analysis and discussion were based on internally available secondary data, supplemented in some cases with findings from the qualitative fieldwork more fully reported in the next chapter. The analysis focuses firstly on performance in terms of both safety outcomes and various operational indicators. It then moved on to examine the factors that appear to have influenced this performance.

PDO's road safety performance was assessed in two main ways. First, an examination was undertaken on trends in four sets of outcome measures: Motor Vehicle Incidents (MVI's), work- and non-work-related fatalities, Lost Time Incidents (LTI's) and Total MVI injuries. Secondly attention was then paid to trends in a number of operational indicators that shed light on the extent to which laid down rules and procedures are complied with and hence the rigor with which they are implemented. These latter measures can therefore be argued to indicate variations in the protective capacity of the laid down safety management system. This second analysis centered on statistics relating to four types of operational defects, classified respectively as A, B, C and D, and compliance with LSRs and NCRs as well as trends in causes of MVIs.

It became evident from the PDO MVI statistics that over the past twenty years a very positive downward trend has occurred. This is most clearly evidenced by the drop in the PDO MVI rate from 2.66 accidents per million kilometres driven in 1998 to 0.33 in 2016, which is notable globally. This positive performance was, in turn, found to exist alongside other positive outcome trends, as well as improvements in the reviewed operational indicators.

At the same time, these factors have clearly not impacted significantly on the number of non-work-related road fatalities since performance here has continued to deteriorate. The reasons for this poorer performance, and what can be done about it, are therefore among the issues that will be explored through the collected interview and focus group data.

In terms of identifying the factors that had influenced PDO's road safety management performance, the chapter sought to identify these through three lines of analysis: the examination of associations existing between trends in various types of violations and those relating to the causes of accidents; the exploration of the impacts of particular safety related initiatives; and the investigation of how far an increasing reliance on driving by sub-contractor staff and self-employed drivers appears to be having an adverse impact on safety performance.

When comparing MVI causes with a number of different violations some interesting patterns emerged. In general, where decreases in violations occurred, this corresponded with decreases in MVIs. More particularly, from 2014 onwards there is a positive downwards trend in violations which corresponds to the same positive trend in MVIs, supporting the logic that less violations lead to less MVIs.

The explorations undertaken to identify the impact of particular safety initiatives were necessarily at times very tentative given the nature of the initiatives and the difficulties associated with examining their effects. Nevertheless, they did generally provide, with varying degrees of confidence, grounds to suggest that safety performance had been influenced positively by the introduction of IVMS, the conduct of hearts and minds campaigns, action in the area of defensive driving, greater and more proactive enforcement, and increased penalties for non-compliance. In doing so, they suggested that the various interventions had, to a greater or lesser extent, exerted a positive influence on PDO road safety performance. More specifically, the linkages identified between trends in particular types of violations and MVI causes suggests that PDO's improved safety performance has stemmed to a significant extent from the way in which these interventions have, either individually or collectively, stimulated improvements in the following areas: speeding, vehicle condition, tyre usage etc.

This evidence of positive effects, alongside other findings highlighting how the impact of some initiatives had faded over time, prompting the need for actions to be taken to reinvigorate them. For example, in the case of IVMS there was a positive change in driver behaviour after its implementation in 2008 but this slowly began to deteriorate until the programme was re-energised in 2013, when again the positive trend began to emerge. This further highlights the importance of monitoring performance and compliance.

The contribution that sub-contractors now make to A defects and LSR violations surpasses main contractors. Furthermore, the number of contractor MVIs are still more than sub-contractors, however the rate per kilometre driven is decreasing, whereas the same sub-contractor trend is increasing. The same can be said for both the LSR and A defect rate per

million KM driven. It could be argued that the increase in sub-contractors has meant that some of the gains in PDO road safety performance was effectively undermined.

The data would suggest the problem with road safety is not just with one contractor and another, it would appear to be at sub-contractor level. Since the Arab spring of 2011 government pressure caused a major increase in the number of sub-contractors operating in the PDO concession area. This suggested two areas for further analysis, firstly the issue with how the main contractors are managing their sub-contractors, discussed in chapter 6. Secondly, how can PDO manage the impact of this shift in the number of sub-contractors operating in their area.

Chapter 6. Qualitative data analysis

6.1- Introduction

In the last chapter quantitative evidence on the road safety performance in PDO was examined and revealed that it had over time improved markedly. It was also used to explore, in a relatively limited way, the factors that had contributed to this improved performance. This latter exploration suggested that a number of interventions had exerted a positive influence over the management of road safety in PDO. It also suggested that they had done so by reducing speeding by drivers, improving tyre usage, improved load security, as well as improvement in vehicle defects.

In this chapter we explore the dynamics underlying road safety management further by drawing on interview and focus group data. The analysis that follows proceeds through three stages. In the first, knowledge and understanding of the organisational rules and procedures related to driving are explored. In the second, compliance with these rules is then examined, along with the factors that influence it. Finally, in the third attention is paid to areas for improvement in knowledge and compliance of PDO road safety. Within each of these discussions distinctions will be drawn between the responses of three different groups of respondents, labelled respectively the ‘architects of road safety policy’, the ‘managerial implementers’ and ‘the drivers’. The PDO driver population is made up of occupational drivers who need to drive as part of their work, and professional drivers where their main duty is driving. The interviews were distributed across these two types of drivers under the three groups mentioned above.

6.2- Knowledge and understanding of the organisational rules and procedures related to driving.

This section discusses the current state of knowledge and understanding of the organisational rules laid down in PDO in respect of road safety. Discussions with participants centred around PDO's main road safety document, SP2000 and focused on gaining insights regarding their general awareness of this document, as well as their knowledge and understanding of a number of key areas covered in it, namely journey management, IVMS, and the consequences matrix.

6.2.1- Knowledge of PDO road safety policy

The architects and implementers of road safety interviewed were invariably very familiar with the contents of SP2000 and also shared a view that it was understood by the contractors. The following quotation from one of those interviewed usefully captures this picture:

"*Yeah, SP2000 is well known and well-established document. People know about it but how deep I'm not sure. This is again a challenging one, I can say whoever needs to know it they know it. It's well communicated, it's rolled out, not this new version, the old version. We went through the thorough procedure of roll out, and campaigns with staff and major contractors. (Architect)*.

The drivers interviewed also exhibited an awareness of SP2000. However, the majority appeared to only have a detailed understanding of the sections of the documents that applied directly to them. For example, a light vehicle driver was not familiar with the responsibilities of a bus or heavy vehicle driver, while Muscat based drivers appeared unfamiliar with graded road procedures as they didn't use them. In contrast, drivers involved

in logistic operations demonstrated a much deeper and broader knowledge of SP2000. In a similar vein, some architects and implementers expressed uncertainty as to how well SP2000 was understood by sub-contractors and their drivers.

The architects and implementers were also questioned as to how they and others had gained an awareness and understanding of SP2000. A response put forward by some of the interviewees was that contractors had a good understanding of SP2000 because this document is required during the tendering process, and subsequently becomes part of the contract documentation for the successful bidder. Others suggested every employee in PDO operations is informed about the document during their induction training, and suggested it was a document they referred to often in relation to ensuring compliance with laid down road safety rules and procedures. For example, one of the architects observed:

"*……, so before we mobilise any contractor we must ensure that they met the minimum requirements. Okay, so indeed such documents as SP2000/01 are playing a big role in the contract community itself so there is a reference to those two documents whenever there is any transportation required within the contract and hence it's not only the major contractors but even their sub-contractors must comply" (Architect).*

6.2.1.1- Journey Management and commuting

Among the architects and implementer group, the general view was that the journey management procedure was well understood at all levels, as the following quotes illustrate:

"*The rules about safe journey management are understood, and today we have got embedded procedures and requirements for every worker, so it's known by everybody.*

Whether it is a manager, the illiterate guy, helpers, they will know something about road safety because they will encounter that somehow if they work for PDO" (Architect).

However, among the drivers interviewed knowledge and understanding relating to the rules of Journey management was generally considered to be more qualified:

"*There is quite very good knowledge. Not of all the procedure by everybody but the minimum that they need to know, is known by the people"* (Driver).

In relation to commuting, it appeared that knowledge and understanding of the laid down commuting arrangements was good among all interviewees, as the following quotes illustrate:

"Now the commuting policy is in and people know about it, so there are people following it, but there are some people, they want to go in their own time and car" (Implementer).

"Commuting to some extent because now we are looking at it on a very I can say, micro- management on a whole through PDO and even PDO is promoting a lot of other alternatives for people to trial from the interiors so yes, yes. I will say even contractors, they are aware, and hiring good commuting alternatives like good buses which are up to the standard so they are hiring those companies also. But still there is again you know, behaviour again there's people who don't want to travel in the PDO pool buses they again bring their own vehicle" (Architect).

This situation was seen to reflect a number of factors. Firstly, it was highlighted that details of the commuting arrangements are highlighted in induction training for all new employees. The drivers also pointed to them being further reiterated through daily and weekly Tool Box Talks (TBT) as well as in defensive driver training. Meanwhile, both architects and implementers noted that the issue of safe commuting is highlighted to staff through ongoing knowledge sharing campaigns, and observed that commuting requirements are written into every contract with contractors, along with a requirement that they report on commuting to PDO every six months on the current work locations of employees, their home addresses, nearest commuting hub and the mode of transport they use for commuting (bus or flight) to and from the work location.

6.2.1.2- In Vehicle Monitoring System (IVMS)

Among the architects and implementers, it was invariably believed that there was good knowledge of the procedures relating to IVMS and the reasons for the implementation of the system. The quote below serves to capture the views expressed by these two groups of interviewees:

"*We have IVMS for example, it has proven that as a concept it is not only working for the operation of PDO but also very beneficial for the contractors and hence everyone will take it on board and in fact we have in certain cases where it was only a sort of compliance to meeting PDO requirement, but the game has changed now. Now you see everyone is aware of it and also, they are aware of its importance to them as a business identity, not only as a milestone but also from a commercial aspect and as a reputation also now is coming to play a big role. As soon as company have a sort of certain trend of accidents within a contractor or within a company then immediately people will be*

blacklisting this company or will not favour to work with them in fact. So yes, I think the majority of the contractors they are aware of that, however are they convinced 100%" (Architect).

The drivers interviewed added weight to such views in confirming that they were aware that vehicles engaged on PDO operations had to be fitted with IVMS, and understood that the system monitored their driving behaviour. However, although most of those interviewed stated that they were receiving feedback on their driving performance from their supervisors, a number said that they were not. The general feeling among the drivers was that they adjusted their driving to best avoid triggering a violation to circumvent negative feedback from their supervisors.

6.2.1.3- Consequences

Many of those interviewed across all three groups demonstrated a good awareness of the consequence matrix which applied to breaches of laid down safety rules. They further indicated that they had gained this knowledge from PDO led campaigns, inductions, Tool Box Talks (TBT) and training courses. The quotations below typifies the type of responses obtained from those interviewed:

"In relation to the possible harmful consequences for not complying with the driving rules I would say people are aware. Ten years ago, I would have said there was little awareness, but now I can strongly say yes, there is greater awareness to the consequences. I believe that the defensive driving training in place now caters for all those requirements. It provides not only awareness, but, the full knowledge about each of

those elements and why they are in place relating to speed and the importance and practicality of seatbelt wearing for example" (Architect).

"*Definitely within the PDO system, they are aware they are life-saving rule violations and the contractor will be fined, and we have had these previously, historically going back to 2010" (Implementer)*

To summaries this section, in general it was found that there was good knowledge and understanding of organisational rules and procedures related to driving. In particular the participants presented a good knowledge of SP 2000, and the procedures related to journey management, commuting, IVMS and the consequences for breaching these rules. While in general knowledge was good, however some differences emerged among the three groups of interviewees. An example of this in relation to IVMS where there were stronger beliefs in the knowledge levels among the architects and the implementers than among the drivers.

6.3- Compliance with the driving rules and procedures

In the previous section it emerged that there appeared to be a strong level of knowledge and understanding of PDO rules and procedures related to driving. This section discusses the themes to emerge in relation to compliance with these rules, and some of the reasons for both compliance and non-compliance. Attention is first paid to issues in relation to which compliance was reported to be high: seat belt wearing, speeding, driving behaviour and vehicle maintenance. Then the discussion moves on to those where compliance is weaker: mobile phone use, journey management and commuting. The section also discusses some of the reasons for both compliance and non-compliance, as well as some generic factors which more generally appeared to influence non-compliance.

6.3.1- Areas of strong compliance

6.3.1.1- Seat belts

When discussing compliance in relation to seat belt wearing with the participants, the unanimous response among all three groups, was that compliance was very strong, suggesting most drivers and passengers travelling in company vehicles within PDO concession area always wear their seat belt. However, it was also suggested that a small number of PDO staff and contractors do not wear their belt when driving their private vehicles in areas outside the control of PDO.

Interviewees put forward several reasons for the high level of compliance with the rules relating to seat belt wearing. The first reason put forward was that knowledge and training played a role in influencing compliance of seat belt wearing, notably in terms of generating an understanding as to how the seat belt actually protects vehicle occupants. Many of the interviewees in all groups suggested that before coming to PDO operations they did not understand how important it was to wear the seat belt. Attention was further drawn to how such understanding was reinforced by the continuous updating and refreshing of the driving rules and the reasons for them. For example, the drivers drew attention to how their knowledge was being continuously renewed through the driver forums and defensive driving refresher training. In a similar vein, architects and implementers noted that meetings, conferences, workshops and tool box talks played a critical role in keeping knowledge of safety issues up to date and at the forefront of minds, and how this in turn contributed to stronger compliance.

Peer pressure was put forward by all three groups of interviewees as another second reason as to why they felt there was a high compliance with seat belt wearing requirements. An example given by one of the participants was how if someone was caught not wearing a safety belt, they would, on the first occasion, receive counselling from their supervisor or senior management, which might cause embarrassment with other work colleagues. Thus, it became clear that most people did not wish to be singled out in front of their management or work colleagues. Interestingly, in contrast, drivers did not put IVMS forward as a reason for seat belt wearing compliance, even though the number of violations has dramatically decreased since the implementation of live monitoring by PDO.

These views were further supported by the responses of the focus groups to the same questions, as the two quotes below demonstrate:

"In PDO the majority of contractors and staff comply with wearing the seatbelt as it is monitored"" (Implementer).

"First of all, it is actually enforced well, what I have seen is most of them they are actually concerned with the seatbelts, and it is very easy to comply" (Driver)

6.3.1.2- Speeding

The general view to emerged from the interviews and focus groups was that there was strong compliance with the rules related to speed limits among those driving company vehicles in the PDO concession area:

"In PDO the most thing they comply with is speed. Because, these things are monitored by IVMS" (Driver).

"The majority of drivers comply with speed and the seatbelts, I think these are the highest things that they really comply with, because the one that we can measure and they know that we can measure" (Implementer).

Those interviewed, however, felt that the drivers of private vehicles, both inside and outside the PDO areas of control, often did not comply with the speed limits, with this view being particularly expressed by drivers. It was suggested by the architects that the drivers of these private vehicles in the interior locations were a mixture of PDO and contractor staff, as well as local residents. The quotes below illustrate these views regarding the poorer compliance with speed limits among drivers of private vehicles.

"Actually, the road speed is 100 km/h then some other private vehicle go too far more than 100 speed. There are some cameras but that does not stop them (Driver)

"In terms of the PDO community, PDO drivers, I have not seen much over speeding, but the thing is like PDO roads are open to the public so definitely I have seen the public population that there is more risky driving, very high speed, unsafe overtaking and things like that" (Implementer)

In terms of the reasons why the participants felt there was strong compliance with speed limits, it was suggested unanimously among all groups that the implementation of IVMS has had the greatest influence on compliance with speed.

Differences emerged among the groups, however, as to how IVMS influenced compliance with speed. For example, the architects generally argued that it allowed management to intervene immediately when a high risk speed event was highlighted, thereby allowing them to coach drivers and reward those demonstrating good behaviour. Discussing the same question with the implementers, it was suggested the reason for compliance was that IVMS allowed consequences to be applied to those drivers violating the speed limits. Responding to the same question the drivers suggested that they complied with speed limits, as their driving behaviour was being monitored constantly, and weekly and monthly reports for all drivers were placed on notice boards. There was a general feeling among drivers that they wanted to avoid embarrassment among peers and supervisors and hence endeavored to drive safely at all times.

Overall, it was clear that interviewees from all groups were aware of IVMS and its function. It was also apparent that, as a result of its implementation and potential consequences, the vast majority of staff and contractors comply with the system's requirements. The below quotations from participants are samples of the typical responses given in relation to the influence of IVMS on compliance with PDO road safety rules and procedures.

"*I was here before when IVMS was introduced to all contractors in 2008, but the focus died away after some time, and then in 2011 there was a second wave. I was rolling it out that time and by establishing the journey Centre now, the third wave, we saw the improvement of compliance by 87%" (Architect).*

"I personally think the IVMS coupled with the real time monitoring system is a game changer. Because this keeps you in the constant loop, your guys know they are being

watched over, and even are being managed, so let's try to follow it, I think then it comes a time when it becomes a practice" (Implementer).

6.3.1.3- Driving behaviour

Driving behaviour emerged as a further area where it was felt in general by all groups that there was strong compliance with driving rules and procedures. However, there were some differences between the groups. The participants considered dangerous overtaking, tailgating, lack of courtesy and non-compliance with signs and road markings as the main types of risky driving behaviour that they observed.

Many of the participants suggested that a number of years ago risky driving behaviour could be observed on a regular basis but compliance with the driving rules was now much better. While the architects suggested that there was more non-compliant driving behaviour in the interior locations, drivers felt it was more so in the coastal areas. Participants further suggested that non-compliant behaviour is usually observed in private vehicles, as opposed to company vehicles and in relation to driving occurring outside the PDO concession areas, particularly in the Muscat area:

"In general terms I don't see risky driving behaviour very often, occasionally you can see some discrepancies and deviations from the rules, mostly in or around the controlled environment of the base camps where there is a low speed limit of 50 km/h, however when travelling for incident investigation outside the camps it becomes clear that the further you get away from the camps you see more drivers tending to overspeed or overtake dangerously which is risky "(Architect)

6.3.1.4- Vehicle maintenance

Vehicle maintenance was an area put forward by the majority of participants across the three interview groups as one where it was felt a strong degree of compliance existed, as the following quotes illustrate:

"*Yes, yes, I have told you main contractors they are maintaining their vehicles but the sub-contractors a little bit… A little bit less! Yes, compared to the main contractors" (Driver).*

"In general, I will say yes, main contractors again I will say yes, their maintenance quality has improved in last 6-7 years but again the sub-contractors and local community contractors again they're maintenance and their standards are quite low" (Architect).

The main reason put forward by all the groups to explain the generally satisfactory situation regarding vehicle maintenance was that the PDO Road Worthiness Assurance (RAS) standard system is in place to oversee vehicle standards. The drivers, in particular, argued that the strong compliance stemmed from how every vehicle had to be inspected annually by a RAS workshop, with a sticker being placed on vehicles that have passed these inspections. These stickers then in turn being the subject of checks by the RSST during its routine vehicle spot checks. Although in passing it should be noted that a small number of drivers suggested that the integrity of this system was somewhat undermined by some stickers being obtained fraudulently, an argument that received a degree of support from the fact that three workshops had been suspended from issuing them.

Slightly differently, the majority of the implementers suggested that the A defect fines imposed by PDO constituted the primary factor behind the strong compliance with vehicle

maintenance standards. Meanwhile, the architect interviewees, in addition to referring to the role of the factors already mentioned, also drew attention to two other sources of positive influence. Firstly, the proactive approach of the RSST since 2014 in conducting vehicle inspections in contractor yards before they went on the road. Secondly, the fact that vehicle specifications and maintenance schedules are written in to every contract, along with the associated consequence matrix.

Notwithstanding these general positive responses, the architects and implementers interviewed did further suggest that there were issues surrounding the maintenance standards of sub-contractors and OTO vehicles. In doing so, they pointed to how this problem was now being addressed by requiring contractors to impose on their sub-contractors the same contractual terms that are imposed on them by PDO.

In this section we highlighted and discussed areas of strong compliance with PDO driving rules and procedures, as well as some of the reasons that were seen to have influenced this strong compliance. Wearing of seat belts emerged as one of these areas of strong compliance. Some of the suggested reasons for this included knowledge sharing, training, peer pressure, the consequence matrix and IVMS. Positive driving behaviour and compliance with speed limits emerged as further areas of strong compliance with the main influencing factor being IVMS. Finally, vehicle maintenance emerged as another area of strong compliance, largely influenced by the requirement of the annual RAS inspection and spot checks by the RSST.

6.3.2- Weaker areas of compliance

In the section that follows, areas that appeared to have weaker compliance, and the possible reasons for this are discussed. The main areas to emerge presenting weaker compliance were mobile phones, journey management and commuting. A range of reasons were put forward for this weaker compliance, such as risk normalisation, workload, lack of ROP enforcement, communication issues, flexibility, economic conditions and beliefs in safety.

6.3.2.1 Driver distraction

Those interviewed suggested that an issue existed with drivers not complying with rules regarding the use of mobile phone while driving within the PDO concession areas. This theme emerged from all groups interviewed and was further highlighted by those taking part in the focus groups

"*At the present moment in time, mobile phones are the biggest issue I have" (Implementer).*

"Mobile Phones. I still stick with the mobile, because over speeding most of the companies now have the fuel cut off system and IVMS control, so they are tight on that, but mobile it is something that you need built in cameras and online to see that all the time" (Architect).

This non-compliance with regard to mobile phone usage was reported notwithstanding that interviewees also generally felt that, as a result of knowledge sharing and campaigns, all drivers were aware of the dangers associated with using mobile phones while driving. A number of explanations were put forward as to why non-compliance with mobile phone rules occurred. It was observed, for example, that for safety reasons staff have limited use of phones when on rig sites, and in many areas there is no signal. Consequently, driving

back to their camp from the rig site provides drivers with an opportunity to catch up on social media and messages. Furthermore, it was argued by interviewees from both the architect and implementer groups that as a result of the increase in social media some people have become addicted to their phones and cannot resist continuously checking them when travelling alone.

A further point raised by the drivers was they felt pressured to answer the phone if it were their supervisor calling. Observations that in turn suggest problems surrounding leadership in middle management since supervisors should not be calling drivers when they are aware that they are driving.

Yet another influence highlighted in all three groups of interviewees was that the use of mobile phones while driving had become normalised by many drivers, as nothing had ever happened to them when doing so. Attention across the groups was therefore drawn to the fact that the chances of getting caught in the more remote concession areas were minimal; a view that led on to suggestions that some form of technology, such as in vehicle cameras, was needed to deal with the problem.

"I don't think they understand the exact requirement, I'm using my phone while driving every day and I know while I'm working in PDO I shouldn't be using it. But why, nothing happened to me while I'm driving my own car. You know. So, the importance of why to comply with certain rules, I think It's not well understood" (Implementer).

In turn, a lack of consequences was seen to be an important factor in explaining why some drivers used their mobile phone while driving outside PDO's area of control. The majority

of those interviewed, for example pointed to how these consequences were much stronger within the PDO concession since the likelihood of getting caught was greater and it was possible for a person to lose their job for driving while using a mobile phone. Meanwhile, and in contrast, it was noted that the ROP fines that can be imposed for mobile phone usage outside of the PDO areas are insignificant. The following quotations usefully summarise the responses obtained in relation to mobile phone usage while driving.

"*If I use my phone while driving inside PDO, they punish you severely. Well it's punishable even if you are doing it outside, but not at all severe" (Driver)*.

"I think drivers just worry about getting caught. I don't think they even think about the danger. I don't think, anybody who picks up their mobile phone to answer it, doesn't think, 'Oh, that's dangerous'. Yes, they understand the concept of not using it, they know they shouldn't use it but they use it anyway, because it's their right. It's part of their life, they are allowed to. It's an important phone call, that person might be dying, I need to speak to them. Oh look, I'm looking in social media. I'm not actually using a mobile phone, I'm looking in social media" (Implementer)

6.3.2.2- Journey management

Among the interviewees of the architect group it was felt, based on recent audits, that the safe journey management system was not being complied with as intended. In their view, the paperwork requirements were being fulfilled. However, the required follow-up monitoring of the driver's journey was not being done. The drivers interviewed, in turn, supported this view, reporting that much of the time there was no communication from the journey manager on completion of a journey. In contrast, some of the implementer group

suggested that in their experience the system was working well. The two following quotations capture the responses of those in the driver and architect groups:

"*There is evidence that people are not compliant with the commuting policy and journey management. They believe like especially journey management is just wasting paper" (Driver).*

"When it evolved first, the safe journey management. when it was launched it was actually complied with, later on it deteriorated, the level of compliance maybe because this was an area where received little attention in terms of auditing and follow up. Many people go there and just look at these papers and don't know and the people, they don't realise that journey management is probably not working because nobody is following it up" (Architect).

A further reason for non-compliance suggested by the drivers was that some journey managers were forced to manage up to one hundred journeys per day, a figure that contrasts sharply with the recommended number of thirty. With this sheer number of journeys, it was argued that it was only possible for the managers to complete the required paperwork, with the result that live monitoring on IVMS did not take place. In addition, it was further argued that some journey managers in small companies had dual roles and were sometimes distracted by the other role, leading to a lapse in following up on journeys.

Additionally, suggested by those interviewed was that communication could be a factor in compliance and non-compliance with journey management. Even though English is the first language of PDO, there was a feeling among the participants that due to the 64 different

nationalities in PDO, sometimes language can become a barrier. It was felt this language barrier may occur at all levels not just the lower ones and lead to cases of non-compliance due to misunderstandings. The following quotations illustrate these observations regarding the problems of in a multicultural environment.

"*This is really important, you will see people talking many languages, they do not communicate the message well that was delivered to them, it might be the managers, might not" (Driver).*

"Then you have an illiteracy problem, the shop level guys can hardly read or write, so this is something that this particular environment in the middle east is facing a lot of challenges" (Implementer).

6.3.2.3- Commuting

As already explained in a previous chapter, PDO has in place a comprehensive commuting system to transport both PDO staff and contractors to and from the interior locations. The general feeling of those interviewed, however, was that the system was not being complied with as intended. A common (but not universal) view expressed by the architects interviewed, for example, was that they were struggling to get staff to comply with the rules on commuting. This problem was seen to be worse in the northern locations, as this was within three to four hours' drive of Muscat, where the majority of staff and contractors reside. The following two quotes are typical of those made with regard to compliance with laid down commuting requirements:

"For commuting we are struggling a lot, we are struggling a lot to a certain case where it is difficult for example to prohibit people from using their private vehicles so indeed we have our own commuting means, we have the flights, the scheduled buses the heavy buses for long journeys and so on, however still people are not convinced" (Architect).

"Commuting is an issue, we are looking at it on a micro-management level on a whole through PDO, and even PDO is promoting a lot of other alternatives for people to travel from the interiors, so yes, yes. I will say even contractors, they are hiring good commuting alternatives like good buses which are up to the standard so they are hiring those companies also. But still there is again you know, behaviour again there's people who don't want to travel in the PDO pool buses they again bring their own vehicle and increase the risk" (Implementer)

Two main reasons were put forward as to why people did not comply with the rules on commuting. One, mentioned by interviewees in all three groups, was a desire among staff for more flexibility. In relation to this, interviewees, for example, observed that if a person brought their own private vehicle to an interior location, then in the event of an emergency at their home they could leave immediately, or when they finished their shift, rather than waiting until the next morning for a flight or bus, as described in the below quotation.

"*It's the flexibility in all aspects. Flexibility in the time you leave your home. You're going to work today, why I should leave at 5 o'clock. I could do some work and leave by 10, especially nearby areas. It gives flexibility on the day you are coming back. You finish your work today you have to wait until other day morning and only 2 hours away or 3 hours away your home from work from night before. It gives flexibility in all aspects" (Driver).*

The second reason put forward relates to the law of Oman. PDO as an employer cannot legally stop employees and contractors from bringing their private vehicles to the interior locations. This has been tested in the courts, the results supporting the right of employees to use their own vehicles. Against this backcloth, the only response available to PDO in terms of discouraging the use of private vehicles is to not allow them to be parked in the camps. However, a number of interviewees argued that the sight of private vehicles parked outside the PDO camps could be acting to create an impression of high levels of non-compliance that itself could encourage others, particularly contractor staff, to act in the same way.

In this section we discussed some of the areas of weaker compliance with PDO driving rules and procedures including some of the reasons put forward for this. The first area to emerge in this regard was drivers using mobile phones while driving. It emerged that the dangers well understood the rules in place, but the risks appeared to have become normalised. This was further compounded by the fact that the chances of getting caught were low due to the sheer size of the concession area. Journey management emerged as a further area of weaker compliance. It was suggested that journey managers were overloaded with journeys to manage, making it difficult to monitor each journey properly. It was further suggested that communication difficulties arose as a result of the multicultural workforce in PDO operations. Commuting to and from the interior locations emerged as another area of weak compliance. The main reason put forward for this was that using a private vehicle gave more flexibility than the commuting transport provided.

6.4- Further reasons for compliance and non-compliance

Some further reasons for both compliance and non-compliance emerged from the undertaken interviews. Below attention is first paid to the former. Then attention is turned to the latter.

6.4.1- Compliance

6.4.1.1- Leadership

Among all three groups of interviewees, there was a common view that leadership in any company has to begin with the CEO or MD. It was argued by both architects and implementers, in particular, that if safety is not a priority at this level, it will not be viewed in this way at other levels. In general, it was felt that most senior PDO and contractor company staff do lead by example. However, it was pointed out, in particular by the drivers, that this is not always the case.

Both architects and drivers also observed that middle management leadership in some contractors was not strong. The architects' suggestion was based mainly on the findings of RSST seven pillar audits, where in some cases leadership and commitment were found to be weak, while that of the drivers was based on their direct observations.

The following quotes encapsulate the general comments made regarding the importance of leadership in influencing compliance with PDO driving rules.

"Leadership, I think, it's started, by the CEO, and it's started by the supervisor in the field. Before I start my engine, I check my car and then others they look. I was operations manager in Marmul and believe me it's powerful when people see their team leader actually

spending time checking their car condition in the morning, switch on, make sure they see you. He's actually spending a couple of minutes to shift things forward" (Implementer).

"Road safety is taken very seriously at different levels and we got a commitment from the MD himself. Once we get a commitment from the MD it shows how much commitment that the company is giving. Our road safety team is directly reported to MSEM, which is Health & Safety Manager, manager is directly reporting to MD. It's getting a very serious commitment" (Architect).

6.4.1.2- Safety climate/culture

The influence of the safety culture/climate in PDO and among contractors also emerged as a reason for strong compliance with the driving rules and procedures. The vast majority of those interviewed felt that beliefs about safety to be influenced by the surrounding safety culture. For example, one of the Architect participants, suggested that his own driving behaviour has been influenced by the safety culture within PDO, in particular with regard to seat belt wearing and mobile phone use while driving.

In line with this, one of the drivers argued that in his organisation, everyone was encouraged to report incidents and near misses, which were dealt with in a positive way in a no blame culture. This driver further observed that his company's top management placed the issue of safety above all others and that this in turn encouraged him to drive safely at all times. In fact, most of those interviewed seemed to feel that if the safety culture is strong, then safety in general will be strong as described in the below quotation.

"If you look at the IVMS performance report, we are doing excellent, yeah. But if you compare the contractors among each other road safety is clearly linked to the safety culture in the company".

At the same time, a small number of the drives interviewed suggested that the safety culture in their organisation was problematic, hence suggesting that commitment to safety varies across contractor companies. For example, some drivers argued that in their company's getting the job done was more important than safety. This is highlighted in the below quotations.

"When the management focus is only on the profit, we can be sure that there will be no focus on road safety".

"Management team will put in some road safety as a standard. But if the job is small or the budget is not there, or their activity is low then they will not bother"

Those interviewed suggested that the reason the majority of drivers continue to drive safely outside PDO is largely due to the influence PDO safety culture has had on their belief in safety. The following quotations offer a sample of the typical responses in relation to the way in which people drive both inside and outside PDO.

"Working in PDO has put me very in a good position, it has led me in a very different way. I cannot do anything without thinking and obey the rules and respecting every human and every situation I know the consequences. So, I take care of myself in every

situation, in private vehicle outside PDO on the road, in everything I do, I believe in what PDO was say and I do it" (Implementer)

Some interviewees, mainly architects and implementers, suggested that people wanted to fit in, both at work and in society outside of work. The comments made by these suggested that that there were two different road safety cultures, one inside PDO and the other outside. While probing deeper as to why this was felt, the reasons put forward were, that while road safety is a top priority of PDO, it has not been given the same level of importance nationally. Those interviewed agreed that fitting in can have both positive and negative influence. In terms of a positive influence within PDO, the interviewees suggested that people do not want to stand out as a result of bad driving behaviour, for example not wearing a seat belt, therefore they comply with the rules. On the other hand, many interviewees felt that once a driver leaves PDO area of control, they want to fit in with their own local culture. An example given by one of the interviewees was that some in the Omani community, particularly males, view those wearing the seat belt as soft, and are mocked for wearing it.

"Within PDO if a lot of people are complying, I will comply because people are watching. You don't want to be a black sheep. And so is you are out of that environment you are going to behave totally different" (Driver).

"*So, what I can see is that the majority of people I will not claim percentage, but what I can see, when they leave the official premises or pass the gate, you can see a different type of behaviour" (Architect).*

6.4.1.3- Enforcement

Generally, the participants felt there has been an improvement in driving behaviour mainly as a result of enforcement. In general, all of the groups suggested that the introduction in 2009 of the Road Safety Standards Body (RSST) had been a significant influence on compliance, and in particular driver behaviour. The participants felt the approach of the RSST towards the enforcement of the PDO rules was helpful. While exploring the reasons as to why they felt this to be the case, it was suggested that the RSST would firstly take a hearts and minds approach to a non-compliance rather than an immediate fine. A further reason given was the proactive measures of the RSST including tool box talks as well as fleet inspections conducted daily in contractor yards. The final point was that the RSST would share feedback and learnings from accident investigations with staff and contractors.

Those interviewed suggested that consequences played a significant role in increasing compliant driving behaviours. More specifically, it was felt by all groups that the introduction of the LSRs and A defects had helped shape compliance, resulting in the good driving behaviours seen presently. However, there were differences among the groups as to which played the greater role in improving compliance. For the drivers, LSR consequences had played the greater role as they affected the driver directly. On the other hand, the architects and implementers felt that the A defect consequences played a greater role, as they were directed at the employing contracting companies.

6.4.1.4- Defensive driver training

Driver training was put forward by the participants as a contributory factor in combating non-compliance in terms of bad driving behaviour. In particular, architects and the implementers felt that a shift in training style from didactic to socratic had enhanced the

effectiveness of training, while drivers felt that refresher training was useful in reiterating the importance of driver attitude and behaviour.

However, among a small number of the driver group there was a feeling that the training message was not reaching all drivers, possibly due to language barriers and intellect. Overall, all three groups suggested that driver training has played a major role in combating negative driving behaviour, the quotations below capturing the general view expressed by those interviewed regarding the beneficial impact of training.

"*I would say, road safety and defensive driving, because this was not of that great quality earlier compared to the quality we are delivering right now" (Driver).*

"Well I think the new defensive driving has to be the fundamental one. Which is in since 2013 rolling out a training methodology, a new paradigm of training methodology in the way we do things, where we've got away from training a person to pass a test in essence and got on to the hearts and minds aspect" (Implementer).

Another point worth mentioning is that while discussing road traffic accident causes with the participants, the majority perceived that speed was a factor in combination with others. In relation to this, many of the participants in all groups felt that breaking the speed limit wasn't primarily the main cause, as this is monitored by IVMS. Rather, the issue was driving too fast for the road conditions. In addition, interviewees also suggested that such driving was often associated with other factors such as fatigue and distraction.

6.4.2- Non- compliance

Two other factors emerged which the participants felt had an influence on compliance, namely surrounding, sub-contracting, economic conditions and culture, age and experience.

6.4.2.1- Sub-Contracting

Among the interviewees in all three groups there was a common view that PDO staff were by far the most compliant drivers, followed by those working for main contractors. In contrast, drivers working for sub-contractors were invariably viewed as the least compliant with PDO driving rules: a perception that also featured strongly among those taking part in the focus groups. The following quotations summaries the general view of the interviewees towards the most compliant drivers in PDO operations.

"*I think PDO staff is the better group, I would say in my opinion they are good drivers, they are safe drivers" (Driver).*

"Less problems with main contractors and less problems or less violations with PDO staff. So PDO staff are best, the second main contractors and the worst are the sub-contractors" (Architect).

"Sub-contractors are coming mostly from the small companies, which are not fully developed in the way we would like them to be developed related to safety or HSE. So, understanding and chasing for the profit or even just for the basic survival, sometimes we can see, or mostly we can see from the sub-contractors who create a large amount of violations" (Implementer).

A possible reason identified by those interviewed for the trend in violations was the lack of a direct PDO consequence matrix. It was highlighted that when a sub-contractor commits a violation or is involved in an accident in PDO operations, it is recorded against the main PDO contractor, who in turn has to pay any fine.

A further group working within PDO operations on a sub-contracting basis merit mention in this regard, namely the Oman Truck Operators (OTO). These are Omani national owner drivers, working as sub-contractors for the PDO primary logistics company. As a result of Omanisation, the PDO primary logistics providers are required to use the services of the OTO where possible to transport goods to and from the concession areas. According to the architects, and particularly, implementers interviewed, it is particularly difficult to get these drivers to comply with the PDO driving rules. PDO and their contractors are endeavoring to improve the safety of the OTO drivers, by applying the same elements of their road safety policy to these drivers.

In addition to this, PDO and the logistics providers offer free training and sponsor the installation of IVMS to their vehicles as incentives. However, a number of interviewees mentioned how, due to the political climate, it had proven difficult to apply the consequence matrix to this particular group. It was reported, for example, that some of the OTO drivers engage in dangerous practices such as speeding and night driving, inevitably ending in both non-work and work related MVIs. This is further supported by the PDO road traffic violations, as well as the reversing accidents statistics where the OTO drivers are over represented. Those interviewed argued that the behaviour of OTOs tends to become problematic when they have no return load back to the port or Muscat, as once they are not

transporting PDO related cargo, they are not under the control of the primary logistics provider. Below is a sample of the view of participants in relation to OTO's.

"*The OTO just will not follow rest, and if we catch them driving without stopping they'll just turn their phones off so we can't contact them. You know, we have cases of night driving where they start far too early, it's just total ignorance to what is common sense to a well versed and well-educated driver. And I just think they don't want to conform" (Implementer).*

6.4.2.2- Culture, age and experience

In all three groups of interviewees it was argued that in general expatriates from Europe, as well as other countries where strong road safety legislation exists, tend to drive more safely and follow the rules. The following quotations usefully summarise the general view of those interviewed in relation to western road safety culture:

"*Why PDO has this strong safety culture is because they have mixed culture, not only Omani's they're mixed up with European, Dutch, British and all these things. And these guys from earlier, they have very strong safety beliefs and safety awareness, I can say that, so they've been passing this kind of information on to these guys, so even their mind set has change, they are getting to the same level of HSE as them" (Implementer).*

"People who come from a background where there is already legislation, road safety legislation in place are more likely to comply than countries where there isn't as strong legislation" (Architect).

In contrast, it was felt that expatriates from regions, like Asia, where road safety legislation is weaker, tend to more often break safe driving rules, either knowingly or unknowingly. They further suggested that in many Asian and Arab countries society pays little attention to road safety, leading to risky driving behaviour being accepted as normal. It was, in this regard, additionally argued that drivers from certain Asian countries tended to comply with the driving rules not because they saw the value in it, but rather for fear of losing their job.

More specifically, it was argued that Omani nationals tended not to comply with the rules to the same extent as other nationalities. Those interviewed further suggested that the Omani drivers felt protected from consequences by the political system. The following quotation usefully summaries the views of the interviewees in relation to Omani drivers.

"I can say that Omani's for the reason, this is their country. They believe I'm in my country and that's it, they simply don't care, I can do what I want. But if for example I will look into Europeans, India and other nationalities they know that they are guests here, and have to comply. Even ourselves if we travel abroad we will obey the laws in that country as we don't want to get into trouble. I feel Omani's at home are still don't care as there are no major consequences." (Driver)

It was additionally, unanimously, suggested by all groups that they felt younger drivers tend not to comply with the driving rules in the same manner as their older peers. Among the interviewees and focus group participants there was a common view that behaviour among the younger drivers is a common factor in both compliance and MVIs. The below quotation usefully captures this view:

"*We have two different cultures within the PDO fence and outside. The youngsters do not care even inside the fence. This is the new generation that doesn't have the deeply imbedded authority. These are the new kids you know. If you speak to someone who is in PDO for 20-30 years, you can see these guys respect the rules. He will not do something really stupid, but those new kids, they think the world is theirs" (Architect).*

Interestingly, it was suggested by interviewees from the architect and implementer groups that where one of their parents worked in PDO, this had a positive influence on the driving behaviour of their children. It was argued that from a young age their parents were introducing them to road safety, where it then became normal, and now this is being passed on to the next generation. The participants suggested that there was a distinct difference in driving behaviour among friends and colleagues that were not exposed to this influence.

"Because my father started there when he was 17 years old so he was raised up by PDO. When we were small, if we enter the vehicle the first thing was seatbelt" (Implementer).

6.4.2.3- Economic conditions

An interesting point raised particularly among the architects, was that it would appear a negative influence on compliance had been the downturn in the oil price over the past number of years. This it was suggested had led contractors to be more focused on survival rather than safety.

Pricing of new contracts, combined with cost reductions in existing ones, it was felt had led to corners being cut. Similarly, while safety training was factored into each and every contract, both architects and implementers suggested that, against this background, some

contractors tried to save costs in this area. In addition, those interviewed suggested more widely that some contractors were willing to engage in forms of non-compliance in order to maintain their profit margins, thereby pointing to a willingness to put profit before safety. The following quotes illustrated clearly the observations made about how recent economic conditions had impacted on contractors:

"*Everything is driven by economy and PDO investing an enormous amount of money in all initiatives including road safety, but the contractors are squeezed, really squeezed big time, and they didn't shift their mindset to a new situation and they are still aiming for the same profit margin, they are still aiming for decreasing debt and to achieve this you know, they clearly have to drop bolts. Some of them are dropping safety and road safety" (Architect).*

"If contractors are under pressure, they just forget about compliance, not only in road safety, but in general. For example, PDO say to people that safety is priority number one, but for me if margins are tight production is priority number one to survive economically" (Implementer).

At the same time, care needs to be taken to not overstate such negative effects. Thus, it was striking that none of the drivers interviewed made similar observations.

It was generally felt among the interviewees that the strong leadership displayed among PDO and senior contractors' management, and the positive safety culture/climate in PDO operations had positively influenced levels of compliance. In general, the majority of interviewees felt that the enforcement role of the RSST had also helped improve and

maintain compliance. Similarly, the implementation of the behavioural based defensive driver training approach was put forward as another positive influencer of compliance.

On the other hand, a number of reasons for non-compliance emerged. Sub-contracting arrangements emerged as a factor in this regard, largely due to the manner in which they were managed, as well as the fact that the PDO consequence matrix could not be applied to them. Culture, age and experience emerged as further reasons. It was generally agreed that the local driving cultures exerted a negative influence on compliance. Younger drivers were also seen to exhibit a lower tendency to comply. Finally, economic conditions emerged as a further factor. It was felt that during times of downward economic pressures contractors focused on survival rather than compliance with road safety rules and procedures.

Areas for improvement in knowledge and compliance

6.5.1- Communication

It was suggested by interviewees in each of the three groups that communication gaps were occurring that were serving to weaken the operation of current road safety arrangements. Firstly, it was suggested by a small number in the driver group that information was not being communicated to them by their supervisors and management. When probing deeper on what particular information was not being communicated, it was reported to include basic information on rules and procedures as well as safety alerts. When asked why they felt this gap was there the reasons put forward were that the supervisors and management were themselves unaware of these pieces of information.

In fact, more generally, the majority of those interviewed argued that communication gaps existed between middle management and the drivers.

"At higher level I can say yes, because they know what the documents are, the content and the requirements. Maybe, we do have some gaps at lower level. At lower level maybe, they need more awareness on the rules and procedures" (Implementer).

In addition, a number of interviewees reported that the communication of policies and procedures from PDO to its contractors was not as effective as it should be, as the following quote illustrates:

"*SP2000 version 4 has been introduced since December, but there are a lot of contractors who don't know still what they have to do, and do not know if they have to follow it immediately, or they have to wait for PDO to get some information, so still there is confusion among the contractors regarding it because again it's not being communicated properly to the contactors level or to their staff and that's what I feel"(Architect).*

Some of the implementers interviewed further argued that language barriers stemming from the multicultural environment were creating communication problems This was notwithstanding that the first language of the oil and gas industry is English, and all PDO training is also delivered in Arabic and Hindi.

"*I think road safety rules and procedures like SP2000 are being communicated but it's not being communicated properly, for example, the standards are mostly in English. When they are communicated to a driver who is an Omani, it's not communicated properly,*

so it's, you know, they don't understand what is there in the standards or what they are supposed to be following". *(Implementer)*

Both drivers and implementers consequently argued that action to improve communications could act to enhance current levels of knowledge and compliance. An example given of this was in relation to driver fatigue, where it was suggested that understanding of the causes and the management of it could be improved through communicating more effectively, a view, for example, expressed by several architects, when making references to the need for the management of fatigue to be something that requires continuous highlighting throughout the PDO community.

It was suggested by a small number of the driver group that much of the documentation in relation to road safety was overly complicated. The drivers interviewed also felt that some of it was too technical and parts were difficult to understand. On the other hand, among the architects and implementers the point was made that it was unnecessary for everyone to understand each aspect of every document, but only the sections relevant to their activities. Nevertheless, both implementers and architects acknowledged that the current documentation was problematic:

"SP2000 as it is now is too technical, and the scope too large with many things repeated, which are contained in traffic law which again nobody reads and is needless. It's kind of like a body of knowledge within a single document which is needless" (Implementer)

"SP 2000 has pages nobody would read, even actually when you go and you put a contract in place, most of the local contracts, they are not going to read through 200

pages and then you know ask questions…… it's key that we continue with simplification to make it simple and easier to understand. Especially our drivers, they are all school leavers, people from around the globe they don't understand, they don't read, the don't write and so on" (Architect).

Over the past number of years PDO has been examining its business processes, striving for increased efficiency. In doing so the Japanese lean approach had been adopted, which focuses on a process, and seeks to reduce waste. This process, it was argued, could be applied to road safety documentation, to ensure it could be more easily understood in the multi-cultural environment of PDO. It was further suggested that, by doing this, the size and the layout of the documents should be easier for all levels to understand, and subsequently follow.

6.5.2- Management of contractors and sub-contractors

A number of implementers and architects argued that there were gaps in the management of contractors and sub-contractors. In particular, some architects suggested that PDO could improve its own management of direct contractors through greater monitoring, something that could be partially done through the new integrated journey management centre where PDO has live access to all the contractor and sub-contractor vehicles, allowing them to apply the LSR consequence matrix immediately for violations. It was further suggested that PDO could, through contracts, impose more severe non-compliance penalties on contractors that do not monitor their sub-contracts properly.

"*Yes, yes, the management of contractor companies are the main driver in implementing Health & Safety rules especially the road safety ones. So, they are playing a*

big role here. If they are paying a lot of time and attention to that ensure there is understanding, everybody will behave, and follow what management believes" (Driver)

The weaknesses existing in relation to the management of sub-contractors by contractors was in turn considered to have led to gaps in knowledge and understanding among the drivers of sub-contractors. Those interviewed suggested, due to contractual agreements PDO has no direct control over sub-contractors, and is completely dependent on contractors to implement PDO rules and procedures. It was further suggested by the implementer and architect groups that some contractors are not cascading the PDO driving rules and procedures to their sub-contractors, nor are they auditing them. The following quotation illustrates the general view of the relationship between the contractor and sub-contractor:

"*Actually, there is a problem when it comes to sub-contractors. There is no effective management of the main contractors to the sub-contractors. We have seen that, I remember we have taken a couple of audits and that proves there is a missing link here you know. And yes, but actual fact, you know, the main contractor's reputation is affected whenever the sub-contractor does something bad with regards to the Health & Safety rules" (Architect).*

As mentioned above, it was further suggested, that as a result of the downturn in oil prices the main focus for some contractors was on profit and survival, rather than health and safety, and in particular road safety. As a result of this, knowledge and understanding of rules and procedures related to road safety were not being cascaded to their lower level staff and sub-contractors. Having said that, it was generally felt, that most companies do cascade the driving rules and procedures to their staff and sub-contractors, and also embraced road

safety. However, the general feeling was management practices in general could still be improved upon.

More specifically, it was suggested that a safety climate survey could be conducted on all contractors to determine whether the climate is positive or negative. Comparisons could then be drawn to establish whether or not correlations exist between good safety culture and good road safety performance and vice versa. Such surveys could, it was suggested, in turn, help identify where any gaps may exist, which could then be addressed with agreed interventions.

6.5.2.1- Fatigue management

A number of participants suggested that driver fatigue was an area where improvements could be made. Driver fatigue is an impairment that, unlike other forms such as alcohol and drugs, can be difficult to prove as a factor in MVIs. When discussing the main factors in PDO MVIs participants unanimously perceived fatigue as a main factor. However, understanding of its nature and role was revealed to be relatively limited.

While the drivers interviewed had heard of fatigue, and knew it was dangerous, they had little understanding of its causes and how its effect could be managed and reduced. More importantly, the interviewees suggested that there was no clear understanding of where responsibilities for its management lay. Among the driver group interviewed, there was a common view that the responsibility for managing driver fatigue lay with the employers and PDO and not with drivers. In addition, among the driver group there appeared to be little understanding of the effects lifestyle outside of work has on driver fatigue. The general lack of understanding of fatigue and its management among the driver group can possible

help explain fatigue as a source of non-compliance leading to MVIs. However, among the other two groups, it appears that there was a good understanding of the nature of driver fatigue, as well as its causes and responsibilities for managing it.

Having said that, all the participants suggested driver fatigue could be understood and managed better, leading to greater compliance and less MVIs. An example given was that during the holy month of Ramadan the fatigue level in those fasting increases as the month goes on. However, the number of road traffic accidents during Ramadan over the past number of years has decreased significantly. This could be attributed to the measures and the awareness programmes that have been put in place, further supporting the idea that greater understanding can lead to greater compliance.

The above themes in relation to driver fatigue were further supported by the focus groups. Among those interviewed there was a common observation that PDO does not have a specific driver fatigue policy or fatigue management procedure in place. Those interviewed suggested that driver fatigue is covered in various different PDO policies, possibly explaining the lack of understanding among some of the interviewees. The findings and issues in relation to driver fatigue raised by the interviewees have similarities to those found in the literature, although the main data in the literature focuses on the implementation of government driven legislation.

The following quotations encapsulates the views presented by the participants in relation to fatigue as a factor in MVIs within PDO operations

"*So definitely it is fatigue because, it's a straight stretch of road and he's coming back from work so definitely he's tired and fatigued and he's lost control and his vehicle has rolled over" (Implementer).*

"I think awareness, people don't understand what fatigue is. It is something new to them, the sign of fatigue, again that's one of the main things. Also, the driver has to be managed you know, so that they don't work beyond their working hours" (Driver).

6.5.3- Training

The drivers interviewed generally felt that the standard of training for basic driving licence acquisition in Oman was an area where improvements could be made. Interviewees pointed out that licence acquisition driving instructors are not monitored and that it was only recently that very basic training was introduced to those entering the profession. Even then, this training does not apply to those already registered.

Instructors, it was argued, were demonstrating bad driving behaviours, as well as bad teaching practices, making their students susceptible to adopting the same problematic behaviours, many of whom would subsequently come to work in PDO. The suggestion was therefore put forward that PDO should engage with the driving instructors through the ROP in order to explore the possibility of developing their knowledge and understanding of basic driving principles, which in turn could improve their level of knowledge transfer to students.

"*Yeah, also, the instructors the basic driving instructors, they are not qualified, because I could see them a couple of times on the road, they are using mobiles while driving,*

they are overtaking. I feel very bad because they have gone out passing on this message" (Driver).

"You know you have to do a lot of training on road safety policies and procedures, it must be simplify to, make it easier to understand, the basic terms, which then theoretically could be pictographically represented in some sort of posters used for toolbox talks, used for HSE forums, meetings and made more appealing or more, how you say it in English, more relevant to a drivers"(Implementer)".

Further to this, there was a general understanding among the participants that a person's personal beliefs influenced the way they drove. Through discussion with the participants it was suggested that they gained their beliefs on driving through family and peers before entering PDO operations. While it was agreed by many of the participants that it was difficult to change beliefs, there was nevertheless a view that this could be done through hearts and minds campaigns and constant and consistent injecting of knowledge to all staff and contractors and sub-contractors. It was further felt that the extension of reflective learning and behaviour based training to all, rather than just higher grades of staff would help in this area, as would translating training materials into more languages.

"Knowledge and keep on injecting this information to people you know, keep on telling them, injecting them until they absorb all that kind of information and I think that this kind of conferences and workshops, they should not target only HSE or safety personnel, it should target the you know majority of people" (Architect).

6.5.4- In-vehicle cameras

As mentioned above, it was generally suggested by the participants that a combination of countermeasures are needed to address the issue of driver fatigue and distraction. The idea of in-vehicle cameras in conjunction with Journey management and IVMS emerged as a theme among the architects and implementers. Such a camera system it was argued would need to have a process for alerting both the driver and journey manager if fatigue or distraction events were detected.

It was further observed in this regard that technology of this type had been tried and tested and was now available in the market. Interestingly, when discussing in vehicle cameras with the driver group, it was not met with the same enthusiasm as the other groups. Below is a sample quotation from a participant which captures the general view of the participants in relation to in-vehicle cameras to combat driver fatigue.

"*You'll never know unless otherwise you are real, real time watching it. One possibility is you fix a camera within the cabin, a decent camera which will be recording into the system itself" (Implementer).*

6.6- Conclusion

This chapter has drawn on interview and focus group data to further examine the operation and impact of road safety management in PDO. The analysis proceeded through three stages. In the first, knowledge and understanding of the organisational rules and procedures related to driving were explored. In the second, compliance with these rules was then examined. Finally, in the third attention has been paid to areas of potential improvement in how road safety is managed. Within each of these discussions distinctions were drawn between the responses of three different groups of respondents, labelled respectively the

‘architects of road safety policy’, the ‘managerial implementers’ and ‘the drivers’. In addition, since the PDO driver population is made up of occupational drivers who need to drive as part of their work, and professional drivers whose main job is driving, the interviews were distributed across these two types of drivers.

Overall, the findings revealed a good level of knowledge and understanding of the PDO driving rules and procedures among employees and contractors, from senior management to the drivers. At the same time, the extent of this knowledge and understanding varied to some extent across these different groups in relation to different issues. In relation to the road safety policy documents SP2000/2001, for example, high levels of knowledge and understanding were exhibited within all groups of respondents. However, those of the drivers appeared to be rather more superficial. Similarly, drivers also had a lower degree of awareness regarding the arrangements in place relating to journey management. In contrast, and perhaps unsurprisingly, the opposite appeared to be the case with regard to LSRs.

Interviewees further indicated that there were widespread levels of compliance with laid down rules and procedures. Once again, however, some variation appeared to exist across the different areas covered by them. The strongest areas of compliance emerged to be those concerning seat belt wearing, speeding, driving behaviour and vehicle maintenance; although a less positive picture emerged regarding driving behaviour in the case of private vehicles. Weaker levels of compliance appeared to exist in the areas of driver distraction, journey management and commuting. With regard to driver distraction, and in particular mobile phone usage, it was suggested that the dangers were widely understood but that they had become normalised. Somewhat similarly, while there was considered to be a strong

understanding of the rules and procedures around commuting to and from the interior, compliance with them was considered to be problematic, in part because of cultural issues surrounding the use of private vehicles by Omani nationals. Meanwhile, it was felt that although compliance with journey management paperwork requirements was strong, it was less in relation to follow-up and communications with drivers.

The obtained findings pointed to a range of factors that were positively influencing levels of understanding and knowledge of laid down road safety requirements and compliance with them. With regard to the former, respondents highlighted the role played by training, hearts and minds campaigns, and driver forums, and thereby added weight to the suggestions in the previous chapter that these had contributed to the improvement that has taken place in PDOs road safety performance. As regards the latter, training also emerged as an influential factor. Others included peer pressure, enforcement, the consequence matrix and IVMS. In fact, IVMS emerged as the greatest influencer of compliance as drivers appeared well aware that their driving behaviour was being monitored live. More generally, among all three groups of interviewees, there was a common view that leadership played a role in supporting compliance with the driving rules, it being felt that most senior PDO and contractor company management led by example when it came to road safety and in this way had contributed to a strong safety culture.

A number of factors were, however, identified as negatively affecting compliance. These included surrounding economic factors and driver culture, age and experience. They also included the growth in sub-contracting that had occurred, primarily as a result of government pressures following the Arab spring of 2011, and, more tentatively, the way in

which the downturn in the oil price had led to downward pressures cost pressures on contractors and an associated focus survival, rather than safety.

PDO could therefore be considered a road safety empire sitting outside the dynamics of business. For example, during the downturn in oil price PDO remained focused on road safety, whereas many of its contractors were focused on economics and survival causing a conflict in priorities. More generally the contractors and sub-contractors working for PDO are businesses with the main focus on productivity and profit and do not see the role of road safety in the same light as PDO. This can create certain conflicts between productivity and safety, for example in terms of the imposition of long working hours and time pressures on drivers that could result in fatigue.

The presented findings pointed to a number of areas were existing levels of compliance, knowledge and understanding could be improved. Some of the areas included communication, management of contractors and sub-contractors, training and fatigue management. Numerous viable suggestions were put forward as to how these improvements could be made. One suggestion was that safety climate surveys should be conducted to identify possible gaps in communication. It was further suggested that implementing the lean process could be simplify documentation and reduce waste. In addition, it was suggested that technology and an improved legal structure could assist in better managing contractors and sub-contractors. Finally, it was suggested that improvements in fatigue management could be made through greater awareness and the use of technology.

Chapter 7: Discussion

This chapter seeks to bring together the theoretical and empirical parts of the thesis. It does so by discussing three main themes. Initially, attention is paid to what new light the present study contributes to existing literature in terms of the potential for employers to improve work-related driving. Following this, the chapter moves on to discuss what new insights the obtained findings provide with regard to the effectiveness of a range of different types of employer-based interventions in improving road safety and to do so not only in the context of existing literature on work-related driving but also that focussed more broadly on the management of workplace health and safety.

7.1- Potential for employers to improve work-related road safety

As has been highlighted earlier, work-related driving forms an important component of all driving (Newnam et al, 2014; Safetynet, 2009; DFT, 2017), and is also a significant source of driving related harm (Australian Transport Council, 2011; H.S.E 2014 and H.S.A et al. 2012). The main causes of work-related driving accidents have also been found to be similar to those identified in non-work-related driving ones (Clarke et al., 2002; Cuerden et al., 2011; Hamilton and Kennedy, 2005; Bener and Crundall, 2005; Broughton et al., 2010; Kimber, 2005; Lloyd et al., 2013; Mohan et al., 2006; Plankermann, 2013; Shalom and Gitelman, 2014; Treat et al., 1979; R.S.A., 2011; Bambach et al., 2012; Richards et al., 2010; C.O.N.R.O.D., 2011 and Twisk, 1995).

It is further argued in the literature that employers can potentially do much to improve the safety of work-related driving (Heery et al., 2017; Naevestad et al., 2015; Newnam et al., 2008; Newnam and Watson, 2011; Clinton et al., 2008; Newnam et al., 2012; Warmerdam

et al. 2017; Wills et al. 2006; Wishart et al., 2017; Newnam et al., 2017; Pidgeon, 2010 and Rowden et al. 2011) on the basis of two strands of analysis. First, on the grounds that employers can be seen to be well placed to act on the five pillars of the safe systems approach that have been found to more broadly influence the scale of driving harm (WHO, 2015; HSA, et al., 2012; HSE, 2014; ESTC, 2012; McAndrews, 2013; OECD, 2008; T.S.R., 2015). Secondly, because employer action can influence the time pressures, fatigue and other factors that have been found to be of particular importance to work-related accidents and which can only be dealt with at the level of individual employing organisations (Malka et al., 2018; Dimmer and Parker, 1999; Heery et al., 2017; Naevestad et al., 2015; Clinton et al., 2008; Small et al., 2014; HSA. et al., 2012).

The road safety performance in PDO lends strong support to this logic. More specifically, its performance can be viewed as highly impressive in relation to (a) internal longitudinal trends in accident statistics and rates of violations (b) road accident trends and performance in Oman (c) international road accident rates.

7.1.1- Longitudinal trends in accident statistics and rates of violations

The current overall rate of work-related driving injury within PDO is impressively low, standing at 0.06 LTI per million km driven, with an overall PDO MVI rate of 0.33 MVI per million km driven. The overall PDO work-related MVIs and LTIs have been following a downward trend over the past 20 years. Similarly, trends in violations, such as LSRs and NCRs, have been following a similar positive downward pattern. The same is true in terms of the absolute numbers of violations occurring each year. In contrast, non-work-related fatalities and injuries arising from private commuting are not following the same trend.

7.1.2- Road accident trends and performance in Oman

Significant differences emerge when comparing PDO road traffic performance with national Omani road safety statistics. For example, in 2015 nationally there were 6279 road traffic accidents resulting in 675 deaths (17 per 100,000 population) and 3624 injuries on Omani public roads (ROP, 2015), while during the same period in PDO operations there were 81 road traffic accidents resulting in six injuries and zero fatalities (0 per 100,000 population). Similarly, with regard to violations in 2013 within PDO there were 146 speeding violations, approximately .004 speeding violation per PDO permit holder, while in Oman nationally there were 3,254,799 officially recorded speeding violations (ROP, 2013), representing approximately three speeding violations per licence holder. Meanwhile, the most recent Oman national data available related to violations (R.O.P, 2013) presents increasing trends in both violations and the number of collisions, injuries and fatalities. This is in sharp contrast to PDO data, which show both violations and MVIs to be decreasing.

7.1.3- International road accident rates

Comparing the PDO MVI rate with other national rates in general it would sit among the top five best performing countries globally (Broughton et al, 2010; McAndrews et al, 2013;Richards et al.2010). For example Ireland which is similar in population to Oman and a top performer in road safety, recorded 5831 road traffic accidents resulting in 162 deaths and 5676 injuries in 2015 (H.S.A., 2016). Since H.S.A. estimates that work related driving fatalities account for 15% of the national death toll, these statistics suggest that 24 fatalities during the year were work-related, compared to zero in PDO during the same period: a comparison which further highlights the strong PDO road safety performance.

In addition, the trend in driving violations and MVIs within PDO are following a similar downward trend as is the case in Ireland also (Siochana, 2016). These comparisons further highlight the strong PDO road safety performance.

7.2- Types of safety interventions that employers can make

The literature review demonstrates that little evidence exists concerning either the elements that can contribute to the establishment of effective employer policies aimed at minimising work-related driving harm or the factors that can hinder and facilitate the implementation of such policies (Rowden et al. 2011; Warmerdam et al. 2017; Newnam and Watson, 2011 and Naevestad et al., 2015). This situation contrasts sharply with the extensive literature within the field of occupational health and safety on the elements required to establish and operationalise an effective OHMS (Frick, et al. 2007;ISO, 2018; ILO, 2001; BSi, 1999). There is, however, some limited evidence relating to the potential value of particular types of employer interventions (see e.g. Grayson, 2011; Naevestad et al, 2018). The findings obtained serve to shed further light on the value of a number of these, namely driver training, group discussions, and IVMS. In addition, it draws attention to the important role that enforcement plays in encouraging safe driving behaviour.

7.2.1- Driver training

The existing literature provides evidence that post-licence driver training can positively influence rates of work-related accidents and injuries. Thus, a number of studies (Gregersen et al, 1996; Lynn and Lockwood, 1998; Bui et al., 2018) have identified reductions in work-related driving accidents and injuries among drivers that had undergone such training. The findings of the current study are argued to lend some support to these findings.

While it is difficult to quantitatively show the impact of driver training on PDO road safety performance, LSR and NCR violations decreased from 2013 onwards, coinciding with the introduction of behavioural based defensive driving training. The qualitative findings meanwhile provide evidence that the change in approach from 2013 onwards to a more behavioural based driver training programme, which primarily focused on the higher levels of the GDE matrix, positively influenced drivers' attitude and subsequent behaviour according to a number of those interviewed.

7.2.1- IVMS

Technology, and in particular IVMS, represent relatively new means of potentially improving road safety. Some existing quantitative studies point to positive links between drivers being monitored and receiving feedback through IVMS and both their future driving behaviour and propensity to experience accidents (Musicant et al, 2007; Knipling and Hyten, 2015; Bell et al, 2017; Toledo and Lotan 2006). The obtained quantitative and qualitative findings of the present study both lend weight to the findings of these studies.

The quantitative findings indicate that following both the introduction, and subsequent re-energising, of IVMS the number of LSR speeding violations declined markedly. They also show the same to have occurred with regard to violations related to the non-use of seat belts. In turn, the positive downward trends in speeding violations and speed as a cause of MVIs were found to be reflected in similar MVI and LTI trends. In addition, and more generally, the quantitative data show a continued decline in violations related to risky driving behaviour after IVMS implementation.

Strong qualitative evidence was also obtained of a significant positive change in driver behaviour after the implementation of IVMS. The evidence suggests that once drivers became aware that their driving was being monitored, and that violations resulted in consequences, they changed their behaviour. The qualitative evidence further strongly suggests that drivers maintained this more positive behaviour. Indeed, the study is seen to suggest that IVMS, as an initiative implemented by an employer, can be one of the greatest influencers in the successful reduction in work-related road harm.

7.2.3- Group discussions

Evidence in the current literature points to the fact that group discussion is an effective intervention in reducing work-related accidents and injuries. Studies examining group discussion in the context of a work-related road safety intervention found there were significant reductions in injuries and accidents after its implementation (Gregersen et al, 1996; Salminen, 2008). Indeed, such discussion have been argued to represent one of the most successful and economically advantageous types of intervention (Grayson and Helman 2011).

The findings of this study provide further evidence that group discussions (driving forums) are indeed an effective intervention. While it is difficult to measure their impact quantitatively, the positive decline in driving behaviour violations, such as those relating to seat belt wearing, journey planning and speeding, are seen to indicate that they have had some impact. This could be largely due to the subject matters discussed during the driving forums since these tended to focus on driver beliefs and attitudes, factors that ultimately influence driving behaviour, as well as relevant legal and moral responsibilities. Moreover,

interview responses strongly suggested that knowledge gained from these discussions had led to an increased awareness of both the dangers and consequences of certain behaviours.

7.2.4- Enforcement

The role of enforcement in relation to work-related driving has not been widely discussed in the literature. The current literature (Toroyan, 2013; GRSP, 2016; OECD, 2008) only refers to enforcement by police and governments, and, often does so, in rather general terms. However, there is some, again very general, discussion relating to the role that enforcement can play in respect of work-related driving (Koornstra and Christensen, 1990). The findings of this study therefore valuably provide new evidence that supports the argument that such enforcement is important.

The introduction of PDO's enforcement teams did not have an immediate effect on violations. However, stronger enforcement after the Arab spring was found to be associated with behavioural, procedural and vehicle violations declining significantly. This was found to be particularly evident after the introduction of a pro-active enforcement campaign in 2014. Furthermore, the observed reductions in violations were found to have occurred alongside parallel ones in associated MVIs and LTIs.

The qualitative evidence points to the fact that due to the coverage and visibility of the enforcement teams there was a high probability of getting caught if violating the driving rules. Furthermore, the evidence indicated that consequences applied to violations in particular LSRs, were seen as severe, acting as a further deterrent. These changes in driving behaviour as a result of enforcement has led to greater compliance, which in turn has had a positive impact on reducing work-related MVIs and LTIs.

7.3- The management of work-related road safety

There is widespread agreement in the literature relating to the components of an effective risk-based management approach to reducing work-related driving accidents and injuries as well as the factors needed to support its effective operation (T.S.R, 2015; Adminate et al, 2017; ISO, 2012). A variety of domestic and international institutions/governments have produced advice and guidance on the management of work-related driving that reflects this collective wisdom (ISO, 2012; RSA, 2013; HSA, 2014 and HSE, 2014). The central elements of this advice and guidance are broadly similar and are clearly reflected in the ISO 39001 standard. They encompass the systematic assessment of risk, the identification of appropriate control mechanisms, the development of strategies to implement these mechanisms, the monitoring and evaluation of their operation, and, where identified, the taking of remedial actions to address any identified operational problems.

To date, however, only a couple of studies (Wallington et al, 2014; Murray et al, 2012) have explored in depth the actual effectiveness of such a risk-based approach. Both these studies centred on large fleets using a broadly similar approach involving the adoption of the Haddon matrix, but refining it to meet their specific needs. The key elements of the success centred around the development and implementation of policies and rules, management culture, leadership and communication. Driver risk assessment proved significant in both studies where a predictive relationship between the outcome of the assessment and collision history were identified. Both studies found that having a road safety management system in place resulted in significant reductions in the number of collisions, insurance claims and costs.

Such advice and prescriptions regarding the management of work-related driving, as discussed earlier, are very much echoed and reinforced by the much more developed and substantial literature on the management more generally of workplace health and safety see e.g. (Frick, et al., 2007; Hopkins, 2006; James, et al., 2007; Robens, 1972; Robson, et al., 2007; Quinlan, et al., 2001; Quinlan, 2015; Turner, 1994; Walters, 2002; Brooks, 2001). Indeed, more specifically attention was drawn to how the management prescriptions detailed in ISO 45001 standard on occupational health and safety very much echo those found in ISO 39001 relating to the systematic management of work-related road safety. Furthermore, in another parallel between the two literatures, the extensive research base relating to the management of occupational health and safety reinforces the findings of Wallington et al (2014) and Murray et al (2012) on work related road safety in showing that a systematic approach to OHS management can be highly effective (Saksvik & Quinlan, 2003; Brooks, 2001; Gallagher, 1997; Gallagher, et al., 2001; Frick, et al., 2007).

At the same time, this wider OHS literature also indicates that this effectiveness (see e.g. Gallagher et al, 2001; Quinlan, 2014) is very much a conditional one that is dependent on the presence (or absence) of a number of factors. For example, disasters have been found to occur, notwithstanding the presence of systematic management structures as a result of design, engineering and maintenance flaws, failures to heed clear warning signals, flaws in risk assessments, flaws in management systems, flaws in systems of auditing, economic/reward pressures compromising safety, failures in regulatory oversight, the ignoring of worker, consultant and supervisor prior concerns, poor management-worker communication/trust and flaws in emergency procedures/ resources (Quinlan, 2014). Similarly, other researchers have highlighted how tensions can exist between the requirements of good health and safety management and the financial priorities and

motivations of employing organisations (Dawson et al, 1998; Nichols, 1997) and the way in which a decline in worker voice and the increased fragmentation of organisational structures and employment (Benassi & Dorigatti, 2015) have served to increase the likelihood of such potentially damaging tensions, as well as the adverse implications flowing from them.

PDO's road management infrastructure can be seen to incorporate the central elements of such systematic approaches to the management of risk. Thus, the development and implementation of the work-related driving rules, policies and procedures contained in SP2000/2001 can be seen to have reflected ongoing processes of risk assessment, performance evaluation, and policy revision. In addition, the document can be seen to encompass a comprehensive array of preventive elements, including IVMS, vehicle specifications, journey management and commuting rules and procedures, driver training and behaviour expectations, and road worthiness assurance (RAS), along with enforcement systems and associated penalties aimed at ensuring compliance with them.

The road safety performance of PDO reported at the beginning of this chapter suggest clearly that PDO's road safety management architecture has supported an ongoing process of safety performance improvement as well as the achievement of impressive accident outcomes. This performance therefore reinforces the case study findings of Wallington et al (2014) and Murray et al (2012), as well as the wider OHS literature, in pointing to the value of organisations adopting a systematic, risk-based, approach to the management of work-related road safety as suggested in guidance provided in such documents as ISO 39001.

At the same time, however, the present study also, in an echo of the wider OHS literature, highlights a number of challenges that confront the effective operationalisation of such approaches, notably in relation to the issues of 'message fade', communication, organisational culture, commuting, sub-contracting, cost pressures, driver distraction and fatigue.

7.3.1- Message fade

Reflecting its unique, longitudinal nature, the study's findings pointed to evidence of 'message fade' and the importance therefore of organisations reinforcing the importance of laid down rules and procedures. Indeed, in a variety of different ways, they provide examples of how PDO had successfully taken actions to reinvigorate particular elements of its road safety architecture. The findings therefore highlight that it is not enough to put in place appropriate preventive elements. Ongoing processes also need to be utilised to ensure that their existence, relevance and importance are continuously reinforced, as emphasised by the ISO 45001 and 39001 standards dealing respectively with the management of work-related driving and workplace occupational health and safety, as well as existing research evidence with regard to the latter.

7.3.2- Poor communication

The qualitative findings of the study confirmed that strong communication exists within the PDO operation and that this had supported the effective implementation of PDO's road safety system. However, the findings also highlighted areas where there were communication gaps. The evidence indicated that there were gaps in the transfer of information from middle management to drivers. Other evidence indicated that due to the multicultural environment of PDO language barriers had an adverse effect on

communication. To a lesser extent, the evidence also suggested that some of the documentation was too technical, making it more difficult to communicate. The findings therefore indicate that such communication gaps have the potential to adversely affect the implementation of road safety management systems, as widely discussed in the OHS literature (Quinlan, 2014; Woolfson, et al., 1996; Hopkins, 2011).

7.3.3- Lack of supportive organisational culture and leadership

Studies, such as those by Newnam et al (2008), Wills et al (2006), Wishart et al (2017) and Newnam et al (2017), present findings showing correlations between safety culture and certain positive safety outcomes. Other studies (I.S.O. 2012; Newnam and Oxley, 2016; Newnam et al., 2012; Shalom and Gitelman, 2014; Wallington et al., 2014; Murray et al., 2012) highlight the role leadership and commitment plays in shaping organisational safety cultures and the management of road safety, as well as work health and safety more widely (Gallagher, 1997; H.S.E, 2014; H.S.A, 2016).

In line with these findings, those of the present study provide strong qualitative evidence that both strong leadership and a positive safety culture existed within PDO operations and had a positive effect on road safety behaviour. For example, those interviewed frequently made references to how one or both of them had encouraged safe driving behaviour within PDO operations and, more particularly, compliance with laid down rules and procedures. At the same time, the obtained findings drew attention to the way in which the variation in safety performance among sub-contractors was attributable to the poorer leadership and cultures present in some of them. In a similar vein, the poorer compliance noted with the laid down rules among those commuting in their own vehicles appeared to point to the negative influence of the wider driving culture in Oman. Together, therefore the obtained

findings highlighted how the effectiveness of road safety management systems can be influenced, both positively and negatively, by the nature of surrounding safety cultures and levels of managerial leadership.

7.3.4- The influence of wider driving cultures

PDO's road safety system exists within a wider cultural setting marked by a more problematic driving culture. Oman nationally has a road fatality rate of 17 per 100,000 population, twice as high as the average for high income countries. As previously demonstrated PDO's road safety system has managed to achieve high standards of road safety, notwithstanding this surrounding context. At the same time, the qualitative findings obtained highlighted that, despite widespread knowledge of commuting policy and procedures, they are largely not being complied with, by both PDO staff and contractors. This was further supported by quantitative evidence showing a high and increasing number of fatalities associated with private vehicle commuting. Such findings therefore highlight the way in which western multinationals can in some countries face challenges from local driving cultures when in implementing systems of road safety management.

7.3.5- Sub-contracting

A number of studies from the wider occupational health and safety literature have highlighted that the economic dynamics surrounding sub-contracting can have adverse safety consequences for those working for supplier organisations (see e.g. Walters and James, 2009; James et al., 2007 and Walters et al., 2012). More specifically, a number of studies have shown how the safety of truck drivers can be endangered as a result of the time and economic pressures, competition, insecurity, incentive payment systems and irregular

working hours embedded in sub-contracting arrangements (Quinlan, 2001; Williamson et al., 2000; Feyer et al., 2001; Mayhew and Quinlan, 2006; Quinlan, 2015).

Within PDO operations there are three types of drivers, ones that work directly for PDO, others that are directly employed by a main contractor and ones that are employed by sub-contractors. The evidence from the study tells us there are grounds for concerns regarding the latter group. The study's findings, for example, revealed that drivers working for sub-contractors tended to be less compliant with laid down driving rules than those employed by PDO or main contractors. They further revealed that sub-contractor drivers were more prone to commit safety violations and that the trend in sub-contractor MVIs was upward, in sharp contrast to the trends among PDO and contractor drivers. Consequently, the obtained findings add weight to the studies referenced in the preceding paragraph regarding how sub-contracting, and the economic pressures and incentives embedded within it, can encourage unsafe driving behaviours, as well as risk-generating fatigue, among drivers.

Such evidence therefore indicates that sub-contracting relationships can create challenges to the implementation and operation of road safety systems. Certainly, the findings obtained suggest that the management of sub-contractor drivers in PDO was in need of improvement.

7.3.6- Surrounding economic conditions

Within the literature on occupational health and safety there is a rich literature which draws attention to how tensions can exist between the operation of laid down safety arrangements and surrounding economic dynamics (see e.g. Frick, 1990; Nichols and Walters, 2013). The contracting and sub-contracting relationships discussed above serve as an important reminder as to how such tensions can be problematic in safety terms. Thus, the qualitative

evidence tells us that the recent downturn in oil prices and subsequent cost reduction requirements both impacted negatively on road safety among contractors and sub-contractors. In particular, the study's findings point to how some contractors and sub-contractors were more focused on maintaining profits and were willing to engage in non-compliance to achieve this. In doing so, they lend additional support to analyses indicating that the cost and delivery demands of power purchasers within supply chains can limit the ability of supplier organisations to invest in health and safety arrangements and incentivise them to circumvent laid down precautions and legal requirements (Walters and James, 2009; James et al., 2007 and Walters et al., 2012)

The findings highlight that for safety arrangements to be fully effective supportive relationships need to be established with the processes of organisation/business decision, otherwise there is potential for them to be undermined by the latter. In this regard, the findings confirm the importance of leadership, but also show how this can be problematic in economic contexts that in effect provide incentives due to variations between levels of management and contractors.

7.3.7- Driver distraction and fatigue

Driver distraction globally although a relatively new phenomenon, is a contributing factor in road traffic accidents and injury (Mayhew et al, 2013; Broughton et al, 2010). The findings of this study both lend weight to such findings and suggest that the risks associated with using mobile phones while driving have become normalised. Furthermore, the findings highlight the difficulty in detecting and controlling mobile phone use. More particularly, the qualitative evidence highlights how their use is difficult to control where fines and consequences are low, and the chances of being caught using them are low. It is for this

reason that a current PDO study is exploring the possible use of technology to identify both driver distraction and fatigue.

Quinlan (2001) highlighted that fatigue among Australian truck drivers was a main contributing factor in road traffic accidents, as well as ill health among drivers. Other studies also highlight the role that driver fatigue can play in road traffic accidents (Naevestad et al, 2015; Warmerdam et al, 2017). The qualitative findings of this study, however, points to evidence of a lack of understanding of its effects, as well as the responsibilities associated with its management. In a similar vein, the findings highlighted that there was no specific driver fatigue policy or management plan currently in place, notwithstanding qualitative and quantitative evidence that driver fatigue is a main contributory factor in approximately 30% of PDO MVI's.

This study therefore more generally highlights how the effectiveness of road safety arrangements can be undermined by the inadequate management of driver fatigue, and suggests that more needs to be done by PDO in the area. Indeed, it suggests that the management of such fatigue needs to be systematically addressed within them.

Conclusion

The findings indicate that PDO has improved road safety, both in longitudinal and relative terms. They therefore lend weight to the argument that employers can make important contributions to road safety. Furthermore, as the factors shown to have influenced its performance indicate, the findings additionally highlight that, like governments, employers

can potentially exert a positive influence through the five pillars of the safe systems approach.

PDO policies have evolved, reflecting an ongoing process of monitoring, review and adaption, echoing the guidance and advice offered by various institutions, such as ISO, on the process of road safety management, as well as widely accepted prescriptions relating to the management of workplace health and safety more generally. The findings also, in common with this wider health and safety literature, highlight that to be fully effective such an approach needs to be embedded in, and extended to, wider processes of organisational/business decision making, otherwise there is potential for it to be undermined by the latter. As a result, they further indicate that the absence of corporate level leadership can adversely affect the implementation and operationalisation of a road safety system. In addition, the findings have pointed to how the implementation and operationalisation of policies need to be continuously reinforced and to be supported by effective systems of communication, and the way in which their effective operation can be undermined and challenged by wider driving cultures, driver distraction and fatigue and processes of sub-contracting.

The study's findings further confirm evidence from other studies that employers have the potential to influence road safety by influencing the skills, motivation and more general behaviour of drivers through various interventions. More specifically, they point to the value in this regard of driver training, IVMS, discussion forums and action to ensure that laid down rules and procedures are meaningfully observed.

Chapter 8: Conclusion

This chapter provides a conclusion to the study. It comprises three main sections. Firstly, the reader is reminded of the study's rationale, objectives and methodology. Then the main implications of the study's findings for current knowledge are detailed. Lastly, some limitations of the study are noted and a number of ideas for future research put forward.

8.1- Study rationale, aims and methodology

Global data reveals that the number of road deaths annually stands at 1.24 million, and that a further 20 to 50 million people sustain injuries as a result of road traffic accidents each year. Such deaths therefore constitute the eighth leading cause of death, and concern has subsequently been expressed that they will rise to fifth place by 2030 unless action is taken to address the issue (Toroyan, 2013; GRSP, 2016; OECD, 2008). Studies shed light on the causes of road traffic accidents (see e.g. Tödtling-Schönhofer and Pucher, 2010; Shalom and Gitelman, 2014). These identify a range of factors contributing to road accidents, which are seen to fall into three main groups, namely those relating to the driver, the vehicle and the environment (GRSP, 2016). They also indicate that the road user is by far the most important contributing factor, with adverse behaviour as its most important component. In line with this, the main risk factors associated with road fatalities globally have been found to be speeding, drinking and driving, non-wearing of helmets, non-wearing of seat belts and non-use of child restraints (Toroyan, 2013).

A further range of studies have been conducted which highlight potential prevention strategies (Broughton et al, 2010; Richards et al, 2010; Toroyan, 2013; Kimber, 2005; Morris, 2006; Peden et al., 2004; Shalom and Gitelman, 2014; Tödtling-Schönhofer and

Pucher, 2010; Wales, 2017; E.T.S.C., 2012 and GRSP, 2016). To date, however, the focus has been on the preventive role of goverrnment and, more particularly, the types of action they can take in relation to five 'pillars', namely safe speed, safe roads, safe vehicles, safe people and post crash care (McAndrews, 2013). As a result, little research attention has been paid to the role of employers in preventing work-related road accidents.

This lack of research exists despite the fact that work-related driving is of considerable importance, and accounts for a considerable amount of driving harm (Australian Transport Council, 2011; H.S.E 2014; and H.S.A et al. 2012), and in sharp contrast to the substantial literature that exists on the systematic management of OHS as well as the factors shaping it (see pages 70-81). It also exists alongside the fact that employers have been noted to be well placed to act on a number of the 'five preventive pillars' and to take action on some of the main causes of work-related driving harm, including fatigue and time pressures (Naevestad et al, 2015; Warmerdam et al, 2017; Tranter, 2010; Clarke et al, 2005; Lynn and Lockwood (1998).

The issue of work-related driving is consequently associated with three, somewhat overlapping, sets of conceptual and empirical weaknesses. The first of these is the absence of a substantial body of research evidence concerning how it is managed, and what influences the effectiveness of such management. The second is that while the management of work-related driving can be regarded as an element of more general occupational health and safety management (OHSM), it has rarely from a research perspective been treated as an integral component of it. As a result, it remains unclear how far the findings of OHSM research can be extrapolated to the domain of work-related driving. Finally, and by extension, it similarly remains unclear how far the management of such driving has, like

OHSM more generally, been impacted by the way in which work has been restructured and externalised in recent decades. These three current areas of conceptual and empirical weakness point to a clear need for more research to be carried out on the management of work-related driving.

The overall aim of this project was therefore to undertake case study research to shed new light on the role the employer can play in reducing work-related driving harm. To support the achievement of this aim, three supporting objectives were developed. The first was to review existing research encompassing a focus on the factors that influence road safety both generally and in the work context, the potential role of employers in improving work-related driving, and the potential insights that can be gained into this role through findings contained in the literature on occupational health and safety management. The second was to undertake new empirical research focussed on the management of work-related driving safety and, more particularly, its capacity to generate improvements and the factors that influence this capacity. Finally, the third was to draw out lessons emerging from these conceptual and empirical strands of the research for current knowledge including for policy and practice, and future research regarding employer management of work-related driving.

To support these aims and objectives three types of data collection was undertaken: semi-structured interviews, focus groups and descriptive statistical data on relevant performance outcomes. In terms of the last of these sources, statistics on various types of safety outcomes, notably numbers of motor vehicle incidents (MVIs) work- and non-work-related fatalities, lost-time injuries (LTIs), and MVI injuries, and trends in various types of non-compliant violations, were collated and analysed. With regard to the other two, qualitative data was obtained from three groups of respondents, the architects of road safety strategies

and policies, those responsible for implementing them, and finally contractor and sub-contractor drivers, that were aimed at shedding light on four main themes: knowledge and understanding of organisational rules and procedures; the extent of compliance with them; the factors that hindered and facilitated such compliance; and the actions that could be taken to improve current road safety management.

8.2- Findings and their contribution

The undertaken study, comprising as it has an in-depth study of road safety management in one organisation, has generated findings of clear relevance to PDO, the organisation concerned, regarding both the strengths and weaknesses of its existing management arrangements and how they might be improved in the future. More particularly, the study has shown how, via a road safety management system of a type promulgated by ISO and other organisations (T.S.R, 2015; Adminate et al, 2017; ISO, 2012), PDO had succeeded in securing ongoing improvements in road safety and achieving, in comparative terms, an impressive road safety performance. At the same time, the findings of the study highlighted a number of ongoing management challenges, with these most notably surrounding the economic context and operation of sub-contracting arrangements. Other identified sources of difficulty included the negative impact of local driving cultures and problems associated with both driver distraction and fatigue. The findings further revealed that the company's performance reflected not just the policies that it had adopted but also the committed way in which senior management supported their effective implementation and the resources that were made available in this regard.

PDO is obviously distinctive in terms of its geographical/national area of operation, the industry sector of its operation and the nature and operational context within which driving took place. The study's findings are nevertheless argued to be of relevance to the management of road safety in other organisations. Thus, as has been seen, they broadly resonate with the, admittedly relatively limited, evidence available on the management of work-related road safety (see further below). Secondly, they accord with the much more extensive evidence within the wider literature on workplace health and safety that point in the same direction regarding the value of adopting such systematic approaches towards the management of work-related risks (Frick, et al., 2007; ISO, 2018; Dalrymple, et al., 1998; Gallagher, 1997; Gallagher, et al., 2001; Robson, et al., 2007; ILO, 2001).

This wider literature, however, cautions against assuming that such systems will necessarily work as intended and therefore that the arrangements in PDO could simply be successfully transposed into other organisational contexts (Reason, 2013; Turner, 1994; Woolfson, et al., 1996; Nichols & Walters, 2013; Hopkins, 2011). Such a need for caution, as observed above, also emerged from the present study in terms of (a) the role played by such supportive contextual factors as senior management leadership, ongoing processes of monitoring and review and the taking of remedial actions where weaknesses in performance were identified, and (b) the way in which a number of factors were found to be adversely impacting the management of road safety within PDO.

More widely, the study's findings are argued to contribute to existing knowledge regarding the management of work-related road safety risks in two ways. First, they add significantly to the available evidence base on it. Secondly, they serve to draw out and confirm often unacknowledged linkages between the literature on work-related road safety and that on

workplace health and safety. In doing so, they point to the importance of road safety researchers much more widely both recognising these linkages and learning from them.

As regards the first of these areas of contribution, while it is widely accepted in the literature that the employer can improve work-related driving (WHO, 2015; H.S.A., et al., 2012; HSE, 2014; ESTC, 2012; McAndrews, 2013; O.E.C.D., 2008; T.S.R., 2015; R.S.A., 2007), little research exists which highlights the factors that facilitate and hinder its effective management: the studies by Murray et al (2012) and Wallington et al (2014) constituting notable exceptions in this regard. The findings of the current study have therefore shed important new confirmatory light on the potential of employers to improve work-related driving safety and the types of actions that enable this potential to be harnessed.

Against the background of limited research on the effectiveness of particular road safety interventions aimed at influencing driver behaviour (Grayson, 2011; Naevestad et al, 2018), the study's findings additionally offer both qualitative and quantitative evidence pointing to the value of four particular interventions. Firstly, defensive driver training, secondly, IVMS, which the authors previously cited suggest constitutes one of the strongest influencers on driver behaviour, thirdly, driving forums and finally, enforcement and monitoring measures.

Turning to the linkages with the wider workplace health and safety literature, the study's findings regarding the application of safety policies to sub-contracting organisations and self-employed drivers confirm the relevance to work-related driving of two important lines of related analysis existing within the literature on workplace health and safety and so point to their relevance to understanding the organisational dynamics surrounding work-related

driving. The first of these concerns the tensions that can exist between the needs of safety, on the one hand, and commercial considerations, on the other (Bennett, 2002; Nichols & Armstrong, 1973; Robson, et al., 2007; Woolfson, et al., 1996). The second involves a recognition of how the externalisation of work to outside providers can generate such tensions in the resulting supply relationships and in this way undermine the application of safety policies to them (see e.g. Walters and James, 2009; Mayhew and Quinlan, 2006; James et al, 2007). In drawing attention to these linkages, the present study's findings have served therefore to importantly highlight the need for road safety researchers to understand the importance of adequately embedding their analyses of work-related driving within the commercial and financial contexts within which driving takes place and safety policies operate.

8.3 Limitations and further research

It is important to acknowledge some of the limitations of the study as well as some areas where further research may prove useful. The analysis of the road safety performance of Petroleum Development Oman (PDO) focused on the years 2008 to 2016 largely due to relatively scant statistical data available prior to 2008. This meant some of the trends prior to 2008 could not be examined in much detail. A further limitation was the fact RSST investigations tend to identify 'immediate' accident causes rather than more distant organisational ones, in part because, for a variety of legal and contractual reasons, RSST may not have access to much potentially relevant pre-crash data.

Juxtapositions between the findings obtained and the existing literature on work-related driving serve to identify several areas where further research could usefully be conducted, namely driver fatigue and distraction: commuting and the associated influence of wider

driving cultures; sub-contracting; and the influence of wider business environments. Furthermore, there is a need for more in-depth case study research similar to this study to both confirm the conclusions emerging from it and to explore their applicability to other organisational and national/cultural settings.

The findings of the study indicate that driver fatigue is an area where further research could be undertaken to shed light on how best an employer can approach its management. Such research it is argued could encompass examining the role of a wider human resource approach that considers the design of work practices that could act to minimise the risk of such fatigue.

While research has been conducted on driver distraction (G.H.S.A. 2011; E.T.S.C. 2012; Basacik et al., 2011; Mayhew et al., 2013), further research exploring how widespread the problem is, and what are its main causes and how they can be combatted could usefully be undertaken. In this area, the effectiveness of electronic devices to monitor driving and the use of mobile phones more specifically constitutes an issue that perhaps particularly merits research attention.

In highlighting problems regarding the driving behaviours of staff and contractors commuting from their homes to interior workplace locations, the current study flagged up the challenges that can be posed by wider driving cultures and the difficulties of addressing them in relation to non-work-related driving. Further research in this area could usefully be carried out to understand the nature of these challenges and how they might be more effectively addressed through the development of countermeasures.

Findings from this study indicate that further research into the safety consequence of sub-contracting and their effective management is also needed. As mentioned above, this area has received significant attention in the OHSM literature. This could contribute further to the existing research base. Research exploring the factors that challenge and facilitate systematic risk road risk management of sub-contractors could provide a deeper insight. Further studies could provide qualitative data on reasons for high non-compliance among sub-contractors, and further ways of improving the client contractor, sub-contractor relationship. Such research may shed light on how problematic areas could be improve, that could help lead to a reduction in work-related driving harm.

Finally, the three areas of conceptual and empirical weakness mentioned above point to a clear need for more research to be carried out on the management of work-related driving. They also highlight more particularly how such research could usefully seek to draw out similarities and differences with the OSHM literature while also more specifically embracing a focus on the way in which work-related driving (and its management) has been impacted by the types of change in the world of work that have been found to create challenges to more general OHSM.

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