Disaster Risk Reduction Initiatives in Road Transportation of Petroleum Products

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ABSTRACT

There has been an alarming increase in disasters during road transport of petroleum products across Africa. In line with the Sendai Framework for Disaster Risk Reduction (DRR), there is a requirement for transporters in the petroleum industry to adopt DRR initiatives. This paper presents DRR techniques transporters can adopt to minimize road tanker accidents that lead to disasters. The study focuses on Kenya, but has implications for the entire continent. A survey was carried out via questionnaires, using random sampling, with a sample size of 391 tanker drivers, who worked for different transporters. The questionnaire included a request for the name of the transporter each tanker driver worked for. Out of the 391 respondents, 318 drivers specified the transporters they worked for. The study classified the transporters into 3 categories, based on the number of road tankers in their fleet. The performances of the different categories of transporters were analysed using data of accidents and spills incurred by their tanker drivers. The findings identified compliance management as a key factor to minimising accidents during road transportation of petroleum products. Managers within the transporters' organizations should be charged with the responsibility of educating tanker drivers about the importance of compliance with driving safety rules. The study recommends adoption of in-cabin on-board computers (OBC) as a tool that can be used in a proactive manner to monitor compliance by tanker drivers and prevent road accidents. Improvement in effectiveness of transporters' organizations, recruitment, training and retention of suitably qualified and well-trained drivers will lead to reduction in accidents and disasters in the industry. The effectiveness of defensive driving training for tanker drivers was reviewed and the predominant perception confirmed its contributions to enhancement of road safety awareness within the industry.

Keywords: Disaster Risk Reduction, Petroleum Products, Road Tanker Drivers, Transporters

I. INTRODUCTION

The challenges of road transportation of petroleum products on the African continent, and associated accidents and disasters, have been well documented (Oguntoyinbo, China & Obiri, 2024). Disasters during petroleum products transportation have become an overwhelming problem on the continent. Almost annually, disasters occur when road tankers get involved in accidents that lead to spills, fire and explosion, with resultant multiple fatalities, injuries, damage to asset and environment. Despite the fact that Africa is the least motorized region (2%) of the world, it accounts for 16% of the globally recorded deaths from road accidents (Uzondu, Jamson& Lai; 2018). Transporters are critical stakeholders in the prevention of accidents and disasters that arise from road transport of petroleum products. Researchers have shown that human factors failures that result in accidents and disasters are connected to underlying failures by individuals at various organisational and operational levels of transporters (Ambituuni, *et al.*, 2015). Therefore, focus should not be on the tanker driver alone, but other parties within the transporter organisation, including supervisors, journey planners, managers and leaders, who may contribute indirectly to accidents. Over a period of time, a culture is created within an organisation, which becomes the way business is done within the company. It becomes the unspoken response of what staff believe is good for them. When staff believe rules will benefit them, they comply naturally (Hudson, 2001). The challenge is to develop a culture within an organization, where rules and procedures are perceived as being beneficial to the staff. This study investigated the performance of different categories of transporters based on accidents and spills incurred by their tanker drivers, and opportunities for prevention of disasters. Transporters have the responsibility to introduce controls that would minimise rate of accident and spills, with the overall aim of disaster prevention. It is important for transporters' leaders and managers to set the direction for good performance in the prevention of accidents and disasters. There appears to be insufficient research

about roles transporters can play with respect to risk reduction in road transportation of petroleum products. This study is expected to trigger further research on DRR in the industry.

1.2 Objective

To examine the root causes of accidents and disasters during road transportation of petroleum products, and the role of transporters in addressing them

II. LITERATURE REVIEW

Research has shown that human behaviour and attitude contribute to road accidents and disasters. Past road safety measures and prescriptions of legal notices have not adequately addressed behaviour and attitude of road users. Change of behaviour and attitude of road users and regulators have great potential of reducing road accidents (Wycliffe, 2019). The change will occur when road users become aware of road transport risks they are exposed to. Disasters have been caused by inadequate awareness of hazards and risks associated with transportation of petroleum products. Regulators and other industry players have recognized that lack of risk knowledge and safety awareness form part of key underlying issues in disasters (Ambituuni, *et al.*, 2015). Therefore, tanker drivers need to be trained to understand hazards associated with their operations, the associated risks, and importance of compliance with rules in the prevention of accidents and disasters. This study investigated roles transporters can play in improving the safety awareness of tanker drivers and controls that can be introduced to prevent accidents during transport of petroleum products

Uzondu et al (2018) have identified transport users' behaviour as the main cause of road traffic accidents. It has been shown that unsafe driving behaviour accounted for up to 90% of accidents. This includes inappropriate speeding and speed-related factors, poor knowledge of traffic regulations, including road signs and markings, drink driving, dangerous driving, driver fatigue and inappropriate overtaking. Tools are now available to identify some of these unsafe driving behaviours, so that proactive measures can be put in place to prevent accidents.

Tanker drivers work in an industry where some of the hazards may not be easily visible, or could be hidden. Borowsky and Oron-Gilad (2013) highlighted that ability to identify hidden hazards can be enhanced through driving experience and training. This study investigated the roles of transporters in identification of root causes of accidents and requirement to place controls that will prevent future occurrence .

III. METHODOLOGY

The study reviewed disasters that occurred in the Kenya during road transportation of petroleum products. A survey involving 391 tanker drivers was carried out in the study area, with the aim of identifying the root causes of disasters, and disaster risk reduction (DRR) initiatives that can be adopted by their transporters. A pre-tested questionnaire was used for the survey and it covered factors that could impact performance of tanker drivers, including compliance with transport safety rules/procedures, engagement with transporters' managers/supervisors and drivers' educational level. The tanker drivers that participated in the survey were randomly selected, and the survey was administered through petroleum marketing companies for whom they delivered products.

In order to investigate their performance, the study classified transporters, the employers of the tanker drivers, into 3 categories:

Small Oil Transporters (SOT): these are small transporters that have up to 9 tankers in their fleet providing services to oil marketing companies; Medium Oil Transporters (MOT): these are medium-sized transporters that have between 10 and 49 tankers in their fleet; Large Oil Transporters: these companies have 50 or more tankers in their fleet.

The number of road tankers owned and operated by each transporter was obtained from the list of registered petroleum tankers (Energy and Petroleum Regulatory Agency [EPRA], 2020). The petroleum marketing companies involved in this study did not own, nor directly operate, road tankers. All the drivers involved in the survey worked for one of the transporters that had contracted them to transport products on behalf of the petroleum marketing companies. On receipt of completed questionnaires, it was observed that some tanker drivers did not provide the names of their transporters (employers), despite repeated reminders for inclusion of the names. It is suspected some drivers intentionally refused to provide the names of their employers for fear of possible adverse effects of the findings. As a

result, data of such drivers could not be included in the analysis of the performers of the 3 categories of transporters. Table-1 presents breakdown of accident and spill performances of drivers from the 3 categories of transporters.

Table-1
Breakdown of Transporters Accident and Spill Performance

Transporters	Total # of Drivers (%)	Drivers with Zero-Accident	Drivers who had Accidents	Drivers with Zero-Spill	Drivers who had Spills
SOT	57 (18%)	48	3	55	1
MOT	24 (8%)	18	6	19	4
LOT	237 (74%)	182	51	211	24
Total	**318 (100%)**	**248**	**60**	**285**	**29**

It was observed that, of the 57 tanker drivers that worked for SOT Transporters, 6 of them did not provide data about their accident, and 1 driver did not provide spill data. Of the 237 drivers that worked for LOT Transporters, 4 did not provide data about their accident and 2 did not provide spill data. For MOT transporters, one driver did not provide spill data.

IV. FINDINGS & DISCUSSIONS

4.1 Response Rate

The study investigated the performance of tanker drivers of each category of transporters, and perceived effectiveness of the transporters' organizations. Performance indicators considered included number of accidents and petroleum product spill incurred during transportation. The compliance with rules by the tanker drivers of the transporters was investigated and comparison was made of educational levels of drivers within each transporter's organisation.

4.1.1 Transporters' accident and spill performance

The analysis of performance of the transporters, with respect to accidents and spills incurred by their drivers, is presented in Figure 1.

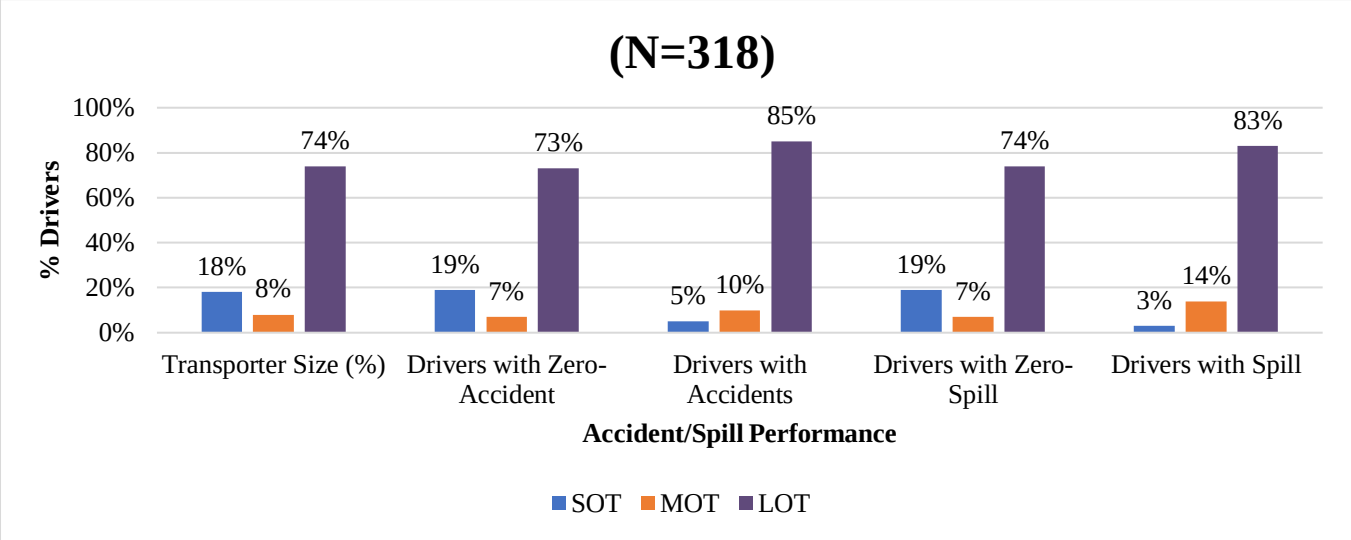

Figure 1
Accident and Spill Performance of Transporters

When zero-accident and zero-spill performances were reviewed, SOT transporters were the only group that achieved performance better than their proportionate population size, achieving 19% of both zero-accident and zero-spill performances, though its size was 18% of overall population. SOT transporters incurred 5% of accidents and 3% of spills, when compared against their population size of 18%, which is good performance. So, for both types of

performance, zero-incident and zero-spill on one hand, and accidents and spills incurred on the other hand, SOT transporters performed better than their proportionate size.

Tanker drivers that worked for MOT transporters represented 8% of the driver population, but contributed 7% of zero-accident, and 7% of zero-spill. MOT transporters contributed 10% of the accidents and 14% of the spills. Hence, the performance of MOT transporters was slightly worse than their population size.

LOT transporters represented 74% of the tanker driver population. However, their drivers contributed 85% of the accidents and 83% of the spills. The drivers also contributed 73% of zero-accident performance, which was worse than their size, and 74% of zero-spill, which was the same ratio as their size.

From this analysis, LOT is considered the worst-performing group of the 3 categories of transporters. The study investigated some of the issues that could have contributed to the performances of the 3 categories of transporters.

4.1.2 Transporters' Compliance Management

The research survey covered compliance with road transport directives, legislative requirements and general driving rules put in place to prevent accidents. The questionnaire requested drivers to state if they had non-agreement with, or lack of understanding of, specific driving safety rules. The reason for this question was for the researcher to obtain a perception of the rules that would most likely be violated. A conscious violation of rules could be either due to lack of understanding or non-agreement. A breakdown of drivers that disagreed with, or expressed lack of understanding of, the driving rules was carried out, and classified as potential non-compliance. This was followed by an analysis of likely impact of non-compliance on transporters performance.

The questionnaire covered the following driving safety rules:

1) Minimum age limit of 30 years
2) Hold transporter's driving permit
3) Annual medical certification
4) Minimum driving experience 5 years
5) Ensure all use seat belt
6) Never use mobile phone while driving
7) Be well rested (driving hours)
8) No alcohol or drugs
9) In-cabin On-board Computer (OBC)

Analysis of the responses revealed 4 of the driving safety rules had the highest numbers of disagreement or lack of understanding: 30-year age limit; driving permit issuance by transporters; minimum 5-year driving experience; and use of in-cabin on-board Computer (OBC). The 4 rules were analysed on the basis of category of transporters and the breakdown of potential non-compliance (disagreements) with the rules is presented in Table-2.

Table-2

Breakdown of Drivers' Disagreement with Key Road Transport Rules

Category of Transporters	No. of Drivers	Rule of 30yrs age limit	Rule of Minimum 5yrs Experience	Transporter Driving Permit	Rule of OBC
SOT	57	16	5	1	12
MOT	24	2	1	2	3
LOT	237	94	20	30	31
Total	**318**	**112**	**26**	**33**	**46**

In order to evaluate the impact of potential non-compliance amongst the three transporters, the study analysed percentage of drivers in each category of transporters that disagreed with the 4 rules. An overview of the disagreement or lack of understanding with the rules is shown in Figure-2.

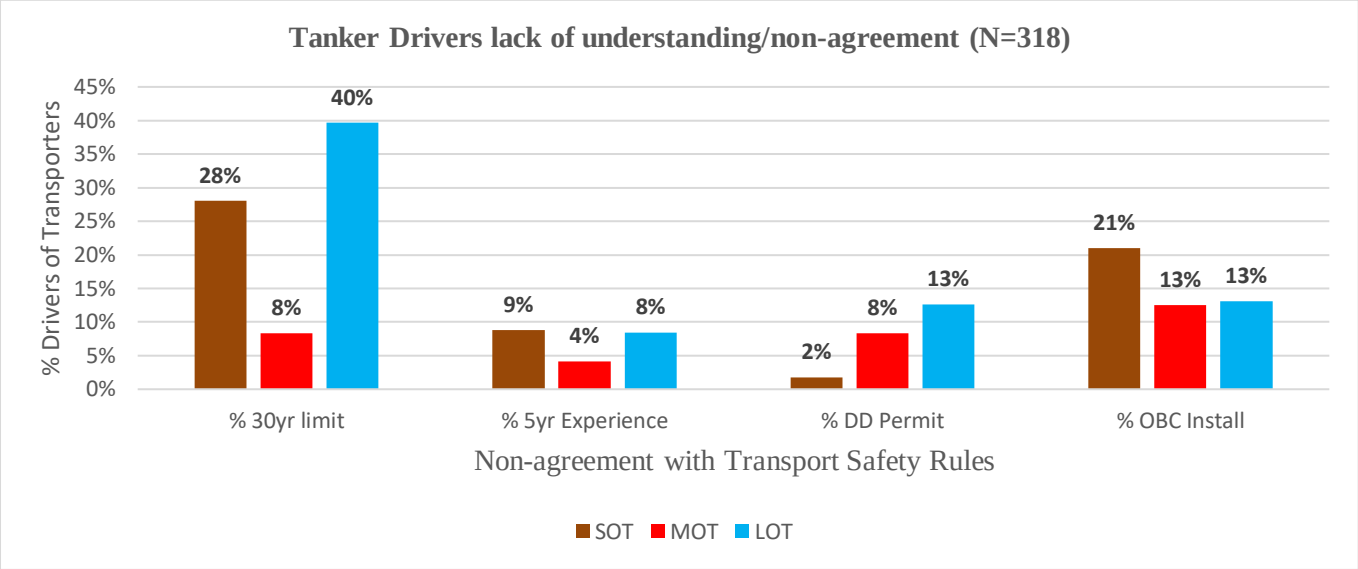

Figure-2
Breakdown of Tanker Drivers' Non-Agreement with Rules

From Figure-2, an analysis of the rules that tanker drivers either disagreed with or were not understood revealed the rule about minimum age limit of 30 years for drivers had the highest level of disagreements, with 40% of LOT drivers, 28% of SOT drivers, and 8% of MOT drivers disagreements. This implied a good percentage of the respondents did not appreciate risks posed by younger drivers. Researchers have shown that three-quarters fatalities of road accidents were caused by young drivers within the 18-30 years' age bracket (Hordofa, *et al.*)

It was observed that LOT drivers, who made the highest contributions to accidents and the highest spill rate (Figure 1), also had the highest percentage of disagreement (40%) with the rule of minimum 30-years age for tanker drivers. That is, of the LOT drivers that responded to the survey, 40% of them disagreed with the rule or did not understand its importance.

The analysis revealed 8% of MOT tanker drivers disagreed with the 30-year minimum age limit for drivers, whilst 28% of SOT drivers also disagreed.

The analysis revealed the rule about minimum driving experience had the least level of disagreement or lack of understanding about its importance. This could be an indication that the tanker drivers generally understood the importance of driving experience as a factor in prevention of accidents.

The analysis presented in Figure-2 revealed LOT drivers had the worst level of non-compliance with driving safety rules in general. This could have contributed to the higher accident and spill rate when compared with the other types of transporters. LOT drivers also had the highest percentage (13%) of non-agreement with the rule on issuance of driving permit by the transporters. The importance of a comprehensive pre-licensing program for drivers, training and renewal has been highlighted by researchers (Uzondu, *et al*; 2018).

On successful completion of defensive driving course, transporters issue driving permit to tanker drivers, thereby formally authorizing them to drive on company business. The defensive driving course and subsequent refreshers provide drivers with skills to facilitate identification of road hazards, and prevention of accidents in difficult environments. Such drivers are able to drive safely, despite the mistakes of other road users. The study revealed LOT drivers had the highest percentage of drivers that expressed non-agreement with the rule about issuance of driving permits. By disagreeing with the driving permit rule, the general perception by these LOT tankers drivers was that training or refreshers in defensive driving skills were not required. Instead, the drivers assumed possession of a standard national driving license was sufficient for driving safely in an industry where the risks are much higher.

The analysis of level of potential non-compliance by drivers of the 3 categories of transporters revealed MOT had the best performance. MOT drivers had the least non-compliance for both 30-year minimum age limit and the rule for minimum 5 years' driving experience.

The level of disagreement with the rule on OBC implied the tanker drivers did not understand its importance in monitoring the driving behaviour of drivers, and highlighting areas for improvement, to prevent accidents. The OBC monitors parameters such as harsh-braking, over-speeding, over-revving, engine idling period, driver duty period, driving hours, rest periods, night driving, and compliance or non-compliance with use of authorized routes. By reviewing these parameters on completion of journeys, each driver can be counselled on infractions and areas of non-

compliance. In the petroleum products transport industry, the OBC is referred to as the "silent policeman", given it provides adequate data for monitoring the driver, in order to encourage compliance with driving rules. The study observed several transporters had not installed OBC in the cabin of their trucks, neither had the regulator made it mandatory.

Where there is non-compliance with procedures and rules, the likelihood of accidents would increase, with consequential economic loss (Tob-Ogu, Kumar & Cullen; 2017). The findings of this study are in agreement with this assertion, because LOT transporters had the worst level of non-compliance, and also had the worst accident and spill performances. This is an indication that the performance of transporters and their drivers can be linked to their level of compliance with rules and procedures.

It is the responsibility of transporters' management to emphasize the importance of compliance. Supervisors and managers should educate tanker drivers on the importance of driving safety rules, which are derived from controls required to prevent accidents and spills. In order to achieve significant improvement, and prevent accidents/spills, institutional roles and responsibilities for important functions of road safety management must be defined, i.e. who should be responsible for the accident data register, road maintenance, vehicle inspection, vehicle register, driver training, driver testing, driving-license register, enforcement of traffic rules, emergency assistance, traffic safety analyses, research and documentation services, and training of professionals (Varhelyi, 2016). With these in place, tanker drivers would appreciate the importance of compliance with driving rules as an important step in accident and disaster prevention.

Non-compliance with rules is largely due to lack of adequate safety education (Uzondu, *et al;* 2018). It is the responsibility of managers to improve safety awareness of the drivers in their organization, and ensure they understand the importance of rules. Raising compliance with traffic safety law has been a key contributor to success in countries that have shown lower levels of road safety incidents in Europe e.g., France, Luxembourg, Belgium and Portugal (European Transport Safety Council [ETSC], 2007). Road transport safety procedures and rules are put in place to act as barriers to accidents that could ultimately lead to disasters. When drivers comply with such rules, they significantly reduce the risks of accidents. As drivers are often on their own, without direct supervision when they drive, their compliance or non-compliance would depend on whether they understand the rules, and believe the rules are important in prevention of accidents. Through training, the organisation can ensure drivers understand the importance of each rule, and how they contribute to accident prevention. When the importance of compliance with procedures is well communicated, and drivers understand the benefits, as well as knowing rules are meant for their own safety, they would comply naturally, rather than being forced to comply. It is appreciated that drivers and workers generally do not go to work each day with the intention of creating accidents, but the environment (organisation) in which they work creates the environment for accidents to happen.

4.1.3 Impact of Educational Levels on Transporters' Performance

The educational levels of tanker drivers in the transporters' organization were further considered, and the breakdown was as presented in Table 3.

Table-3

Breakdown of Drivers' Educational Levels

Drivers' Educational Level	Tertiary	Secondary	Primary	Drivers With No Formal Schooling	Total
SOT	5	40	12	0	57
MOT	2	19	3	0	24
LOT	28	148	51	10	237
Total	**35**	**207**	**66**	**10**	**318**

The educational levels of drivers of the 3 types of transporters are shown in Figure 3

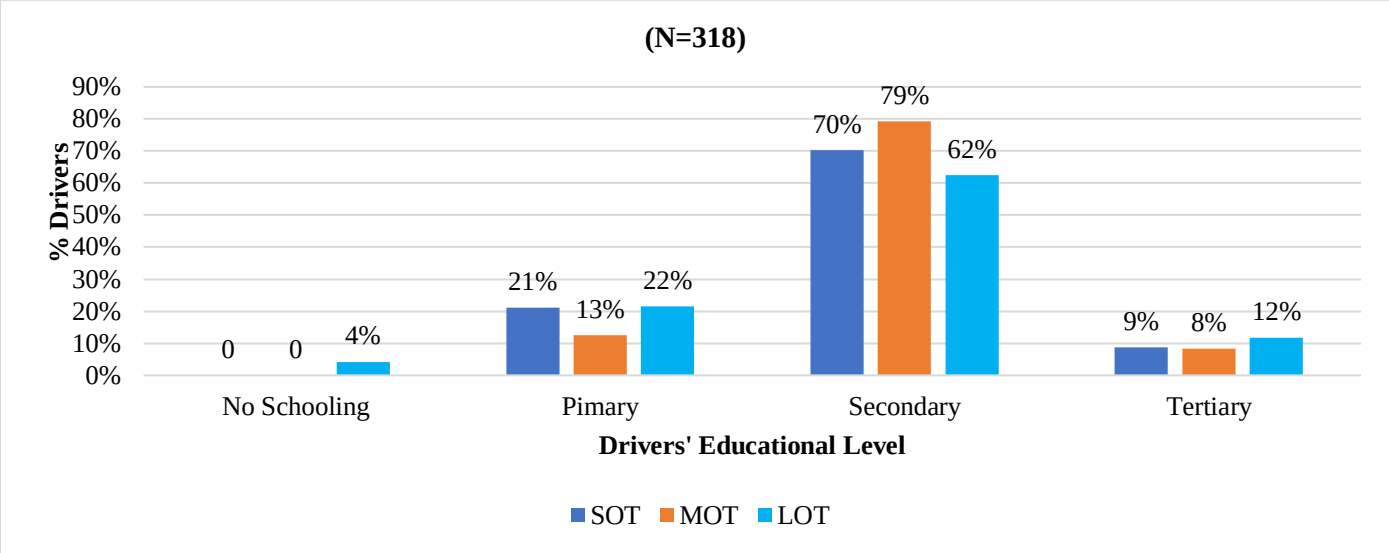

Figure 3
Educational Levels of Transporters' Tanker Drivers

All SOT and MOT drivers had formal education, and both groups of transporters had a good percentage of drivers who had secondary education, with 70% and 79% of their respective populations respectively. The accident and spill performance of both SOT and MOT drivers could be related to the fact that there were no illiterate drivers in the group.

It was observed that LOT drivers had the highest variable of driver education, from those with no formal education (4%) to those with tertiary education (11%). LOT transporters were the only group that had tanker drivers with no formal education. This could have contributed to the higher accident rate of LOT transporters compared to the other categories of transporters. With no formal education, it would be difficult for drivers to understand driving rules, procedures or traffic signage.

Research carried out in Ethiopia (Hordofa, et *al*; 2018) revealed that drivers who had primary level education or lower caused a larger number of fatalities, whilst fewer fatalities were caused by drivers that had a minimum of secondary level education. This study is in agreement with the research carried out in Ethiopia, as LOT was the only group whose drivers had no formal education, and also had the highest percentage of drivers with primary education (22%), compared with MOT (13%) and SOT (21%).

Bhattacharjee, Neogi & Das (2011) posited that education is important in accident prevention activities. Well-trained and educated people may avoid accidents and injuries when carrying out risky activities compared with the uneducated.

4.1.4 Effectiveness of Defensive Driving Training

The study investigated the perception of tanker drivers about the effectiveness of defensive driving training. The questionnaire involved evaluation of effectiveness of defensive driving training, and responses were grouped on a 5-point Likert-scale (Fully Agree, Agree, Not Sure, Slightly Disagree and Disagree). The feedback from the drivers was analysed on the basis of the 3 category of transporters they worked for, and presented in Figure 4.

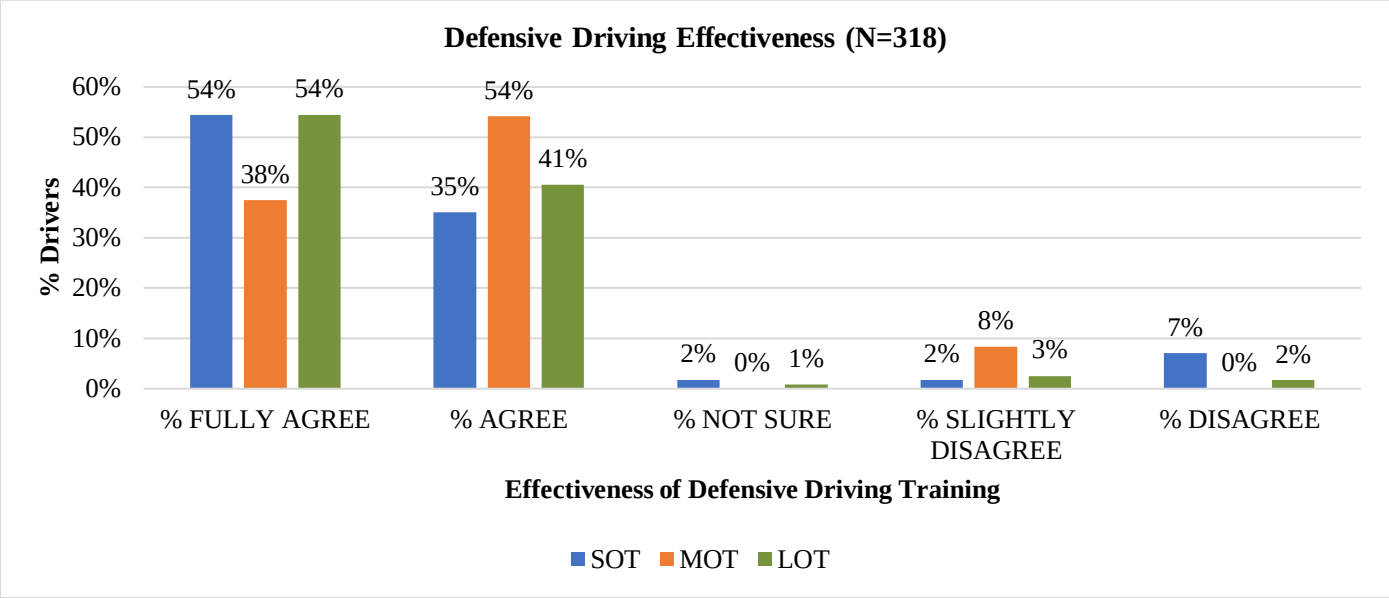

Figure 4
Perceptions about Defensive Driving Effectiveness amongst Transporters

It was observed that 54% of tanker drivers of SOT transporters fully agreed about effectiveness of defensive driving training, whilst 35% of the drivers agreed, 2% were not sure, another 2% slightly disagreed and 7% disagreed. For MOT drivers, 38% of them fully agreed about effectiveness of the training, 54% agreed, none was unsure, 8% slightly disagreed and none disagreed. It was observed that 54% of drivers of LOT transporters fully agreed about effectiveness of the training, 41% of them agreed, 1% was unsure, 3% slightly disagreed and 2% disagreed.

The analysis showed an average of 92% of the drivers across the three categories of transporters believed that the defensive driving course was effective, as they either strongly agreed or agreed. These tanker drivers were more likely to comply with road transport safety rules and procedures, which were emphasized during the training. It was however observed that 9% of the drivers working for SOT transporters, 8% of MOT drivers and 5% of LOT drivers either disagreed or strongly disagreed about the effectiveness of the training. When drivers appreciate usefulness of the training, they are expected to naturally comply with all rules and procedures, to prevent accidents. Involvement of supervisors and managers of drivers, through engagement and face-to-face meetings, where individual performance and challenges are discussed, is considered essential to change the perception of these drivers, and win their "hearts and minds".

Varhelyi (2016) has posited that best-practices in road safety management system must focus on results, and importance of governmental and top management leadership and management capacity. This emphasises the importance of transporters' leaders and managers in setting the direction for good performance.

Akerboom and Maes (2006) have demonstrated that root causes (i.e., latent failures) are the result of fallible management decision, which have their origin in the organization's culture. Therefore, the transporter's organisation and its culture can be influenced by decisions taken by the management. There is no gainsaying that, by creating the right environment, management can improve the organisation's culture, contribute to addressing root causes, and reduce accidents and disasters.

The role of the transporter and its management in improving the safety awareness and performance of drivers has been well highlighted. Oggero et *al.* (2005) identified the need to train transport professionals as a major issue in the prevention of accidents and disasters. Transport professionals include fleet managers, driving trainers, road safety managers road safety managers and journey managers who work closely with drivers in their business activities and their development. The leaders of transporter's organisations are expected to recruit the right quality of drivers that can be trained to contribute towards prevention of accidents. The criteria to be considered by the transporter organisation during recruitment of tanker drivers should include age, driving experience, education and health, among others. Organisational issues set the framework for sustainable transport operations, where accidents and disasters are prevented through the performance of well-trained drivers and other staff.

Ewbank et *al.* (2019) identified the most significant contributing factor to both morbidity and mortality in transportation of petroleum products was scooping of fuel. This is largely driven by underlying social environment factors when tanker accidents or rollover occur, in which a rare opportunity to gather spilled fuel by nearby

community members is perceived to vastly improve one's personal and family circumstances through the use or sale of reclaimed fuel. It is of particular in low-income countries around the globe, especially in Africa. This is a challenge that transporters need to train tanker drivers to be prepared for; to be able to warn the public and initiate access control measures that would minimize crowd access to the event site. Tanker drivers with the appropriate level of education, and increased safety awareness through training, will be better prepared for such role.

Some of the limitations of this study have been considered. As random sampling was adopted in the survey, subsequent analysis revealed drivers that work for LOT transporters represented 74% of the respondents. Whilst this is considered representative of the class of transporters that work in the petroleum industry, contributions of the smaller transporters (SOT and MOT) in the analysis may have been impacted. In addition, 19% of the respondents (n=73) did not signify the transporters they worked for, despite requests to do so. However, given the 3 types of transporters were equally affected, it is believed these limitations may not have had a huge impact on the findings of the study.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

This study revealed transporters have a key role to play in DRR initiatives to prevent accidents and disasters during road transportation of petroleum products. Managers and supervisors within transporters organizations can influence tanker drivers to comply fully with driving safety rules and procedures, through improving their awareness that rules/procedures are key barriers in the prevention of accidents/disasters. Compliance is an important factor in DRR for road transportation of petroleum products, and transporters should focus on how tanker drivers can be influenced to comply fully naturally, rather than compliance through compulsion.

The study also revealed that the OBC, which is installed in the truck cabin, can be used in a proactive manner to enhance tanker driver compliance with rules and procedures. The OBC and other associated factors can contribute to improving the performance of the drivers (Ayres, *et. al;* 1996). These factors include face-to-face engagement of supervisors with tanker drivers, review of OBC reports, feedback on the way they drive, and identified areas of non-compliance during trips. That way, tanker drivers can be encouraged to comply, as non-compliance is dealt with as they occur.

Transporters should be diligent in recruitment of the right calibre of tanker drivers who meet the minimum requirements, including secondary school educational level, age, driving experience, etc. The defensive driving training was recognized as a platform for effective dissemination of rules and procedures applicable for safe road transportation of petroleum products. Through industry regulators and appropriate road safety training companies, transporters can be requested to play more active roles in management of tanker driver recruitment, training and retention to achieve breakthrough performance in DRR and achievement of Goal Zero: that is, no accident, no spill, and no disaster in the industry.

5.2 Recommendations

From analysis carried out in the study, it is recommended that each transporter should set up a scheme to actively monitor compliance with road safety rules by tanker drivers, and apply proactive measures to prevent accidents through reward of compliance, as well as penalty for non-compliance. One of the effective ways of influencing compliance can be via installation of OBC in all cabins of road tankers, and review of OBC reports with each driver at the end of each round trip. Some of the findings from OBC reviews will include violations of seatbelt use, over-speeding, driving-hours, driving-duty period, rest periods, authorization to drive, use of authorized routes, etc. These can address root causes of accidents. It is therefore recommended that the use of OBC on all road tankers should be made mandatory by both the regulator and the petroleum marketing companies.

The study also recommends improvement in effectiveness of transporters' organization through training of managers/supervisors on their roles/responsibilities, and involvement in annual defensive driving training, during which the importance of compliance can be further emphasized. The managers/supervisors, in liaison with the HR department, can ensure the appropriate calibre of tanker drivers are recruited, trained and subsequent retention, to achieve breakthrough performance in road safety, and prevent accidents/disasters.

REFERENCES

Akerboom, S., & Maes, S. (2006), Beyond demand and control: The contribution of organizational risk factors in assessing the psychological well-being of health care employees. *Work & Stress, 20* (1), 21-36.

Ambituuni, A., Amezaga, J. M., & Werner, D. (2015). Risk management framework for safe transportation of petroleum products in Nigeria: Learning from past accidents and good practices. *International Journal of Risk Management, 17*(4), 329-351.

Ayres, T.J., Donelson, A., Brown, S., Bjelajac, V.M., & Van Selow, W. (1996). *"Onboard Computers and Accident Risk"* ASME 1996 *International Mechanical Engineering Congress & Exposition*, Paper No. IMECE1996-0698, pp. 1-6.

Bhattacharjee, G., Neogi, S., & Das, S.K. (2011), Safety Knowledge of LPG Auto-Drivers and LPG Tank Drivers. *Open Journal of Safety Science and Technology, 1*(2), 101-107.

Borowsky, A., & Oron-Gilad, T. (2013). Exploring the effects of driving experience on hazard awareness and risk perception via real-time hazard identification, hazard classification and rating tasks, *Accident Analysis and Prevention, 59*(1), 548-565.

EPRA. (2020). *List of registered petroleum road tankers: Transport of Petroleum Products by Road*. *Retrieved* Available from: https://www.epra.go.ke/services/petroleum/petroleum-licence-register/ (accessed 11th April 2024)

ETSC. (2007). *Raising Compliance with Road Safety Law, 1st Road Safety PIN Report*. ETSC. *Retrieved Available from:* https://etsc.eu/1st-annual-road-safety-performance-index-pin-report/

Ewbank, C., Gupta, S., Stewart, B.T., Kushner, A.L., & Charles, A. (2019). *A Systematic Review of Oil Tanker Truck Disasters: Identifying Prevention Targets.* Carolina Digital Repository.

Hordofa, G.G., Assegid, S., Girma, A., & Weldemarium, T.D (2018), Prevalence of fatality and associated factors of road traffic accidents among victims reported to Buravu town police stations between 2010 and 2015, Ethiopia. *Journal of Transport and Health, 10*(1), 186-193

Hudson, P. (2001). Safety culture: The ultimate goal. *Flight Safety Australia*, September–October 2001, 29-31.

Oggero, A., Darbra, R.M., Munoz, M., Planas, E., & Casal, J. (2005). A Survey of Accidents occurring during the Transport of Hazardous Substances by Road and Rail. *Journal of hazardous materials, 133*(1), 1-7.

Oguntoyinbo, O., China, S., & Obiri, J. (2024), Human factors contributing to accidents and disasters in road transport of petroleum products in Kenya. *African Journal of Empirical Research, 5*(1), 184-194.

Tob-Ogu, A.; Kumar, N. & Cullen, J. (2017), ICT Adoption in Road Transport in Nigeria – a Case Study of the Downstream Petroleum Sector, *International Journal of Technological Forecasting and Social Change, 131*(1) 240 - 252

Uzondu, C., Jamson, S., & Lai, F. (2018). Investigating Unsafe Behaviors in Traffic Conflict Situations: An Observational Study in Nigeria. *Journal of Traffic and Transportation Engineering (English Edition), 6*(5), 482- 492.

Varhelyi, A. (2016). Road Safety Management - The need for a Systematic Approach. *The Open Transportation Journal*, 10, 137-155.

Wycliffe, K. N. (2019). *Economic related impacts on livelihoods of participants of road crash disasters along the northern corridor road in Kenya* (PhD Dissertation, Masinde Muliro University of Science & Technology, Kakamega, Kenya).