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RESEARCH ARTICLE

The Effect of Road Communication Technologies on Driver Compliance in Uganda

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Abstract

The abysmal number of road fatalities and statistics globally indicating that human error accounts for 80-95% of road accidents, their impact instigates an urgent need for all possible measures to enforce driver compliance to road safety regulations. This paper sought to establish the effect of Road communication technologies (RCTs) and driver compliance in Uganda. It discusses RCTs and their implementation towards enforcing driver compliance to safety regulation in developed countries and how they can be provide support to the road safety regulation enforcement unit(s) in Uganda to mitigate road accidents.

Keywords: *Road communication technologies, Driver compliance, Roads, Uganda.*

Introduction

Road traffic accidents globally caused over 1.27 million deaths; millions of others sustained injuries and permanent disabilities [33]. In developing countries like Uganda, statistics indicate that casualties of traffic accidents have increased by 6% between 2010 and 2011 from 2620 to 2843 respectively [1]. The fatalities mostly affect the young between the ages of 15-44 thus destroying enormous human potential [33]. Recent studies suggest that the injuries sustained as a result of road accidents contribute 2.2 2 percent to death globally. It is also further noted that over 90% of the world's fatalities on the roads occur in developing countries, which have only 48% of the world's vehicles [33]. Such statistics reaffirm our understanding of road carnages as a global health problem.

However, 80 to 90% of the road traffic fatalities are attributed to Driver Non Compliance (DNC) to road safety regulations [19], [24], [21], [20], [32], [9], [34] & [35]. DNC is an output of bad driver behaviours such as excessive speed, drunk/drug driving, failure to wear a seat belt, etc that are responsible for the road fatalities.

The introduction of Road Communication Technologies (RCTs) has provided support towards enforcing Driver Compliance to road safety regulations as a preventive action to reduce the number of road fatalities. Road communication technologies like GPS, speed guns, breathalysers have been developed, deployed to enforce driver compliance to road safety regulations [19]. RCTs through telematics have also brought about a transition in automobiles. Telematics has seen a birth of vehicles with a plethora of sensors to enable monitoring and control of engines, thus offering functional improvements and support such as collision warnings hence enforcing driver compliance [11].

Studies have shown that DNC to road safety regulations can be attributed to social norms [34], poor road infrastructure [35], absence of road communication technologies in the country [19] and human error that has been the major cause of road accidents due to their behaviour and attitude [7]. However, they do not discuss or indicate the effect of RCTs towards driver compliance to road safety regulations. This paper aims to assess the effect of road communications technologies towards driver compliance to road safety regulations in Uganda.

Literature Review

The failure of drivers to comply with basic road safety legislation is the main cause of serious road accidents [24]; [21]. Human error usually a result

of bad driver behaviour accounts for about 80% to 95% of the road traffic crashes [7], [19]. This is as a result of driver non compliance to road safety regulations. Driver non compliance may include; reckless driving, over speeding, inconsiderate use of the road, incompetent drivers and driving under the influence of alcohol or drugs, use of mobile phones while driving, etc. The Road Safety Action Programme [4] proposes a series of measures such as stepping up checks on road traffic, deploying new road safety technologies, improving road infrastructure and measures to improve users' behaviours. The ultimate objective is to halve the number of people killed on the roads through enforcement of driver compliance to road safety regulations. In developed countries, RCTs are considered integral in the efforts to reduce traffic fatalities [3], [2].

RCTs are technologies developed to provide intelligent solutions to today's transport problems by preventing, avoiding or mitigating road accidents [8], [20]. Driver compliance can be defined as a state of driver's behaviours being in accordance with established regulations (road safety regulations) or in the process of becoming so [41]. Due to the increasing number of road accidents, driver compliance to road safety has increasingly become a 3 concern of governments' globally. This has led to enactment of road safety regulations (international and local) that compel driver compliance to prevent or avoid accidents [4].

In Uganda, recent statistics indicate that road transport carries about 99% of passenger traffic, as the mode offers flexibility and ability to move between many different origins and destinations. However, as a result, there is an unacceptably high number of accidents [36]. The number of accidents increased from 19867 accidents in 2007 to 22,272 accidents in 2011. In 2007, Uganda fatality death rate per 10,000 vehicles was 78, compared to Kenya with 37 and Tanzania 45 [18]. The Commissioner for Traffic in the Uganda police says undisciplined drivers are the biggest problem on the roads. "You cannot police every inch of their mind. They are just driving badly. You cannot rely on enforcement that you will give them a ticket; he will take it but continues to drive recklessly". [39]. Studies have also indicated that at least 93% of road accidents are caused by driver non compliance to safety regulations. Causes of road accidents due to driver non compliance include; passive safety measures like having to keep distance from the car ahead thus avoiding rear-end collisions, fatigued drivers, overtaking at the wrong time and spot, drunk/drug driving, over-speeding[18].

According to the Uganda Police Traffic report, [37], Road accidents claimed more than 3,000 people; another 13,137 people received permanent bodily deformities like loss of legs and arms, while 1,755 people received minor injuries. The traffic report statistics also indicated that 26.4% of total accidents occurred between 11:00pm and 7:00am. Majority of the drivers during the indicated hours are under the influence of alcohol or drugs given the lifestyle of Ugandan communities.

Fatalities caused under the influence of drinks/drugs were estimated to be 40% in Uganda [6], [5]. The traffic law against drunk-driving is not adequately enforced by police due to insufficient equipment to test alcohol content in blood or breathe yet previous research already showed that alcohol is a likely contributing factor of accidents [30].

According to the WHO report [38], Uganda had 2,954 deaths in 2010 as a result of road accidents, Nigeria had 4,065 and South Africa registered the highest number at 13,768 by 2009. It was also stated that "While Ethiopia, Kenya, and Tanzania have relatively low (for the region) road fatality rates, Nigeria, South Africa, and Uganda combine big populations with very high fatality rates, resulting in large numbers of deaths,".

The high number of road carnages is also attributed to the fact that the Uganda Police is still a very labour intensive affair. The Uganda Police has 1,700 underequipped traffic personnel of whom 800 are deployed in Kampala alone. Of the 800 traffic police in Kampala, 700 are only manning traffic jams. With the right equipment, the whole of Kampala would require only 200 traffic personnel. Besides the low equipment levels of the police, the other problems that necessitate the 'wasteful' deployment are systemic, for instance, the non-installation of traffic control lights at major junctions. Poor planning for its part is also responsible for the presence of narrow roads with bottlenecks at vital places [6].

However, there has also been reduction in the number of road fatalities. Uganda Police intervention has targeted the different causes of accidents according to their contribution to the carnage on our roads. Most accidents in Uganda are caused by human error and so enforcement of traffic laws being stepped 4

up. Uganda Police Force (UPF) has also in the past few years stepped up its public awareness campaigns for road safety through media and workshops targeting specific groups including "boda boda" cyclists, bus owners and taxi drivers. The Integrated Highway Police Command was also set up for enhancement of security domination in accident prone areas, motorized and foot patrols, community mobilization, information sharing amongst stakeholders and quick removal of broken down vehicles and other obstacles from highways [6]. Therefore, various measures have been initiated to enforce driver compliance to road safety regulations. This has also created a window for RCTs to help in enforcing driver compliance to road safety regulations.

Road Communication Technologies can be defined as a range of systems or gadgets that can be applied to detect incidents, support traffic supervision and manage or provide real time information to road users and hauliers [42].

RCTs offer new and intelligent solutions to today's road traffic and accident problems. Road communication technologies like ABS, ESP, ACC, Hypo vigilance system, alcohol lock can assist the driver in the driving functions, thus preventing, avoiding or mitigating road accidents, achieving a key objective of reducing road accidents for most initiated road safety programmes globally [4]. Technological road accident prevention measures focused on the driver have led to a steady reduction in the number of road fatalities on European roads [15]. RCTs reduce the proportion of accidents due to the human factor by 95% [19]. These technologies operate either externally by applying them to detect certain outcomes, autonomously on board the vehicle, co-operatively through vehicle-to-vehicle or vehicle-to-infrastructure communications [14].

In European, RCTs make it possible to ensure driver compliance to road safety regulations as provide support through speed limit checks, detection of alcohol levels, lane support, safe following, pedestrian protection, improved vision, driver monitoring and intersection safety [20], [19], [2], [15]. This helps to enforce driver compliance to safety regulations.

In Europe, analysis of 11 studies evaluating the effects of speed camera technology found an average reduction of 19 per cent in the number of casualties. In Finland, wide scale application of random breath taking tests using breathalyzers sow a reduction in the number of excess alcohol traffic regulation offender's drop from 33 to 14 per 1000 tested drivers [16].

In Uganda, the UPF procured hundreds of high quality Speed Guns and Breathalyzers also popularly known as "kawunyemu" that have helped to net drivers who do not comply with road safety regulations such as over speeding and drunk driving. This has seen a reduction in accidents caused by drunk driving thereby saving many lives. Increased monitoring has targeted speeding through the use of speed guns, reckless driving and inconsiderate use of motor vehicles by the speed enforcement unit [6].

However, although many RCTs are already available, their market penetration is very slow and when they are due, large-scale deployment takes a very long time as tends to start from top end of the market to trickle down to mass markets, for instance introduction of ABS to the mass market took 20 years. Also factors like the extremely competitive situation of the automotive sector, lack of awareness 5 of existence of such technologies, legal and institutional barriers and perceived high cost of technologies [39] have slowed the applicability of RCTs to enforce driver compliance.

According to Charlce, [37], certain RCTs have also been pointed out to pose a hygiene concern. For instance, it is common to see the Police in Uganda using the same gadget (Breathlayzer), forcing people to put it in their mouth. There are fears that they can spread diseases like Tuberculosis and the spread of dentures and gum disease. Doctors also say that some body organs produce natural alcohol from the body and this could give the Police the pretext that one is under the influence of alcohol and yet he/she is sick. They also say some compounds could be misinterpreted as alcohol by the breathalysers, especially with diabetic patients. The use of RCTs significantly requires government action to ensure interoperability and harmonizing technical solutions through a comprehensive approach to benefit from these technologies towards enforcing driver compliance to road safety regulations [14] & [3].

There is clear evidence that RCTs have a significant positive relationship towards enforcing driver compliance to road safety regulations. As earlier discussed, causes of road accidents due to driver non compliance include passive safety measures like having to keep distance from the car ahead thus avoiding rear-end collisions,

fatigued drivers, overtaking at the wrong time and spot, drunk/drug driving, over-speeding, non compliance to road intersection rule [18]. As a result of the different driver non compliance behaviors, various technologies have been developed to help detect or support traffic supervision [42], [20], [2] thus helping to enforce driver compliance.

For instance, driving under the influence of alcohol/drugs that has contributed 40% to the causes of the road fatalities [6] can be mitigated by equipping traffic law enforcers with breathalyzers to detect for alcohol levels beyond the acceptable limits, thus detaining drivers until the alcohol content in their bodies lower and also penalize them to refrain from the behavior. The lately manufactured cars have inbuilt alcohol lock systems that can detect the alcohol levels in the driver, if the alcohol drunk is above acceptable level to drive, the vehicle automatically locks the engine [15].

Road instructions also oblige drivers to create some distance between their car and the car ahead, in the event of not obliging to the rule, Adaptive cruise control (ACC) system in built in vehicles, helps a driver to keep distance from a car ahead avoiding rear-end collision. Hypovigilance systems in cars such as alarms, visual effects or vibrations help fatigued drivers to keep vigil [42].

Over speeding by some drivers especially those driving public transport vehicles can be mitigated by enforcing installation of speed governors that dictate the maximum speed of a vehicle. The traffic enforcement unit can also use speed guns to detect the speed of the driver especially in areas with indicated maximum speed limits [12] & [13].

According to the European Union news letter [42], accelerated deployment of innovative technologies (telematics) enable cooperative systems that allow communication between vehicles thus helping toenforce driver compliance to avoid accidents due to non compliance to intersection rules.

Research carried out in Europe, Japan and the US indicates an 8% reduction in accidents, if vehicles were equipped with systems to maintain a safe speed and keep a safe distance (Adaptive Cruise Control) and prevent unintentional lane departures (Lane Departure Warning) [14]. This is an indication that RCTs can be used to help enforce driver compliance especially in circumstances where law enforcers are not in position to monitor and control the behavior of drivers towards road safety regulations to counter road accidents.

Methodology

The research followed a cross sectional as opposed to the longitudinal study due to time constraints. A correlation survey research design was applied to find out the relationship between the variables.

Trained traffic police officers deployed on highways in the different regions of the country constituted the main focus of this study. A total of 1094 traffic officers were targeted as the study population. Simple random sampling technique was used to allow an equal probability for all the members to be represented in the select respondents [24]. Using the Krejcie & Morgan [27] table to determine the sample, a total of 285 respondents was selected to comprise the sample for the study. The questionnaire was developed and pretested through a Confirmatory Factor Analysis (CFA) to assess the validity of each construct in the model while the reliability of the variables was assessed basing on Cronbach [29]. A total of 118 questionnaires were returned making a response rate of 41.4 per cent [28].

The questionnaire was self administered by respondents who selected a suitable number on the Likert scale; ranging from SD=1 Strongly Disagree to SA=5 Strongly Agree, as a response measure of their perception on the given variables. The structured questionnaire measured the following variables. Road Communication Technologies – measured using; web - enabled service metric, data reliability metric, time and cost metric, E - response metric, invoice presentation and payment metric, E - document management metric, [20]. Krauth, et al. [40] has used some of these measures as performance indicatorsin logistics service provision studies. Safety Regulation Enforcement was measured using; the general regulatory attitudes, Perceived regulatory effectiveness and the perceived effectiveness of regulatory enforcement mechanisms [21].

For ethical research reasons, Research Assistants were given a general introduction letter from Makerere University Business School that was presented to the Commissioner Traffics' office as proof that the intentions of the study were strictly academic and that the findings would only used for the later. It should also be noted that the questionnaire was reviewed by the Commissioner

Traffic's office to ensure that the data to be collected would not compromise the security operations of the traffic police. 7

For each respondent, consent was also sought by the questionnaire administrators in charge before handing over the questionnaire to be self administered. The respondents were asked to sign the questionnaire trucking sheet but not to include any information that would identify them on the questionnaire. Quantitative data analysis was carried out using a Statistical Package for Social Scientists (SPSS) to establish the correlation among the variables and a correlation coefficient was run to establish the direction and strength of the relationships between variables. A regression analysis was carried out to determine the predictive strength of the independent variables on the dependent variable. From the results, inferences on safety regulation enforcement were made.

Discussion of Findings

The response rate attained to generate these findings was hampered by the dynamic nature of the respondent's deployment system that made follow up for feedback complex. The sensitivity of the traffic police force activities on the bearing of the country's security also biased some of the respondents to stay away from providing the required information.

Characteristics of Respondents

The personal characteristics of the respondents indicate that the study was dominated by male traffic officers (74.4per cent), with the dominant age group being 25 to 35 years (48.7per cent). Most traffic officers had a certificate as their highest academic qualification (62.1per cent), with the majority earning below Shs.400, 000 Uganda shillings (94per cent). The study captured more field officers (71.3per cent) than middle level managers (28.7per cent) and no high level manager with majority having worked in the force for over 8years (48.3per cent). Likewise, most of the traffic officers that took part in the study were from the central region (63.6 per cent).

Correlation Analysis

Table 4.1: Showing correlation analysis results

		Road communication technologies	Driver compliance
Road communication technologies	Pearson Correlation	1	.433**
	Sig. (2-tailed)		.000
	N	118	117
Driver compliance	Pearson Correlation	.433**	1
	Sig. (2-tailed)	.000	117
	N	117	

**Correlation is significant at the 0.01 level (2-tailed).

A correlation analysis in table 4.1 above was done to determine the strength and direction of the relationships between road communication technologies and driver compliance. Results indicated that road communication technologies is positively correlated with driver compliance, ($p<.01$).

Regression Analysis

Table 4.2: Showing regression analysis results

Model	R	R Square	Adjusted R square	Std. error of the estimate
1	.433a	.187	.180	.41295

Reference to table 4.2 shows that road communication technologies (Beta = .433, $p<.01$) had a significant positive effect on driver compliance. The predictive power of the model was found to be low at 18.7%. However, the model was robust (Sig. $F<.01$), in that the independent variable in the model was found to be a good predictor of driver compliance.

Research Implications

From the findings in table 4.1 and 4.2, there was a significant positive relationship between RCTs and driver compliance ($p<.01$) with the independent variable predicting an 18.7% change in the dependent variable. From this, it is acceptable to infer that an increase in RCTs will result into an 18.7% improvement in the level of driver compliance to road safety regulations. This implies that the adoption of RCTs will increase driver compliance to road safety regulations on Ugandan roads. It could also mean that the adoption of intelligent transportation systems Young and Regan, [31], ranging from external

gargets (breathalyzers, car tracking and navigation, traffic signal control systems, variable message signs, automatic number plate recognition or speed cameras) to In-vehicle systems (ABS, alcohol lock, hypovigilance, ACC, etc), and then to more advanced applications that integrate live data and feedback (driver profiles, weather information, parking guidance), will increase driver compliance to safety regulation [17]. It is also be concluded that such a driving environment surrounded with road communication technologies would positively improve compliance of drivers towards road safety regulation [19].

In developed countries, road communication technologies have advanced to the level of telematics solutions "wireless connectivity established between passenger vehicles and infrastructures" that integrate live data from the machines (whether vehicle to vehicle, human to vehicle or vehicle to cloud) on the road to aid in driver compliance to road safety regulations [19] & [17]. According to Derek et al, [19], the use of RCTs for immediate road tolling supports Douglas and Swartz [21] findings as it increases the drivers' perception of the effectiveness of safety regulation enforcement. This is through automation. For example; automated road blocks at rail way crossing [22], that will not allow vehicles to cross until it is safe, speed governors connected to car trucking systems that cut the engine speed once the set speed limit is exceeded, weighing bridges that will not allow trucks to proceed if their weight is beyond what is prescribed etc, are some of the road communication technologies deployed to ensure effectiveness in the enforcement for traffic regulations. However, in developing countries, there is 9 attendance of traffic law enforcers to disregard driver time as they enforce compliance to road safety regulations. With the application of road communication technologies, the pairing of computerised devices in the vehicles with the safety regulation enforcement gadgets or micro computers would realise faster information exchange for real time decision making during safety regulation enforcement, based on accurate data.

Policy Implications and Recommendations

The government of Uganda has taken an initiative through the 3 E's of Education, Engineering and Enforcement and issuing appropriate regulations as a measure to reduce road accidents. Under legislation and enforcement, use of road communication technologies like speed guns, breathalyzer has been recommended in an attempt to enforce driver compliance towards road safety regulations. The revelation that road communication technologies can predict an 18.7% change in road safety regulation enforcement as a single variable is a significant contribution of this study towards improving road safety in Uganda. The significant positive relationship revealed in the findings implies that governments can increase the level of traffic law enforcement by equipping traffic officers with more sophisticated electronic equipment like speed guns, scanners, breathalyzers, radio communication gadgets, among others, and encouraging importation of intelligent cars [16].

The statistics from the Uganda traffic police report, [6], indicate a reduction in the number of road accidents by 10 % and expected to improve due to stepped up enforcement of the law using RCTs i.e. speed guns and breathalyzers on highways and urban roads [6]. Given that the number of vehicles on Uganda's roads has doubled in the past five years from 363,658 in 2007 to over 700,000 [1], there is more need to step up on the enforcement of driver compliance to traffic regulations. Therefore, with the tremendous increase in the number of road users and the alarming statistics of road carnages, in developing countries like Uganda, government can embark on equipping the road traffic enforcers with RCTs through the related ministry (MW&T) and institutions (UPF) to help in enforcing driver compliance to road safety regulations as the few procured RCTs have already shown a significant reduction in road fatalities. Government can also intervene by setting up incentives encouraging road users to import lately manufactured cars (intelligent cars) equipped with sensors to help warn drivers in the event of non compliance to road safety regulations. For instance, intelligent vehicles keep alarming when a seat belt is not buckled, cruising control when a driver doesn't keep the recommended distance from the car ahead, engine lock on detection of certain alcohol levels, etc.

The use of RCTs to enforce driver compliance to road safety regulations should be accompanied bypublicity in order to increase awareness among drivers and also increase public acceptance. Using road communication platform supported by telematics will see should help the amount of information shared among the different road users to increase awareness and support for the

deployment of RCTs to achieve driver compliance and therefore better road safety standards.

Research Challenges and Limitations

Like any other study, this one did involve overcoming some challenges and limitations with the most significant being accessing the respondents for feedback given the sensitivity of their profession. The traffic force that formed the respondents of the study fall under the country's security system whichmeant limits on access and the amount of information as some of it is classified. However, we must 10 acknowledge the contribution of the Commissioner Traffic's office that on request provided the researchers with the necessary assistance.

Gaps were also identified on the availability of local information on the variables. It was established that there is less of empirical data and more general opinion information especially in the local newspapers and magazines regarding road safety and enforcement in road transport. This challenge was addressed by reviewing relevant literature from studies done in the more developed countries like Germany, France, Poland Great Britain, Australia and Trinidad & Tobago.

Furthermore, a longitudinal rather than the cross sectional approach that was used for this study would have been preferred to ease the trucking of issues relating to improvement in road safety regulation enforcement over the years. However, this was not feasible given the resource limitations in terms of time and funding. To incorporate the longitudinal aspect of time, literature reviewed was stretched as far back as the year 2000 in order to truck the changes in the road safety regulation enforcement process.

Conclusion

Studies have proved that 90% of road carnages are due to driver non compliance to road safety regulations. Field tests have also proven that road technologies can cut accidents by up to 30- 40% and also showed that driver behaviour improves due to use of these technologies. This is a practical demonstration of the power of RCTs to save thousands of lives. Therefore, indicating a positive relationship between RCTs and driver compliance.

Areas for Future Research

Future researchers in this area can start by targeting different respondents. The selection of traffic officers as respondents without consideration of the road drivers' opinions creates some bias in the findings. Other researchers can head out and establish how to improve driver compliance but this time targeting drivers as respondents.

The other contribution would be in establishing other variables that positively affect driver compliance besides road communication technologies. Studies have shown safety awareness and road infrastructure as some among the many other variables that could have a bearing the levels of driver compliance in the Ugandan roads.

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