IATSS Research 45 (2021) 190–197

Contents lists available at ScienceDirect

IATSS Research

Research Article

Evaluating the effectiveness of a smartphone speed limit advisory application: An on-road study in Port-Harcourt, Nigeria

Anderson Etika [a,*], Natasha Merat [b], Oliver Carsten [b]

[a] Department of Civil Engineering, Cross River University of Technology, Calabar, Nigeria
[b] Institute for Transport Studies, University of Leeds, Leeds, United Kingdom

ARTICLE INFO

Article history:
Received 24 March 2020
Received in revised form 12 September 2020
Accepted 29 September 2020
Available online 10 October 2020

Keywords:
Intelligent speed assistance
Road safety
Crashes
Speeding
Driver behaviour

ABSTRACT

The development of mobile phone applications that provide speed limit advice and warnings offers opportunities for use of the technology in the improvement of driver safety. This paper looks at the effect of an advisory Intelligent Speed Assistance (ISA) application on driver speeding behaviour. Twenty participants (all males within the age range of 35–60 years) completed a within-group experimental design. Participants drove in real traffic on a 46 km test route which incorporated three-speed limits zones (50 km/h, 60 km/h, and 80 km/h speed limits) and aggregated into 10 different segments. Compared with baseline levels, possible impacts of ISA system functionalities on driver behaviour were studied through appropriate metrics including cumulative speed distribution, mean speed, speed deviation, 85th percentile speed, percentage distanced travelled above the speed limit, and safety benefit estimation. Results indicated the use of the ISA application led to significant improvement in speed limit compliance particularly in the 60 km/h and 80 km/h zones where speeding was eliminated. There were no observed negative effects on driver speeding behaviour from the use of the system. In general, the findings suggest the use of the ISA system, resulted in the adoption of vehicle speeds that are likely to improve road safety.

1. Introduction

Every year approximately 1.35 million people die (equivalent to 3700 deaths every day), and an extra 50 million people are injured from road traffic crashes (RTCs) globally [1]. While the cause of crashes is quite multi-factorial, it is generally agreed that speed limit violation and inappropriate speed are the biggest contributors to road traffic crash occurrences and severity [2]. An increase in speed leads to the increased distance of travel during the driver's reaction time with the stopping distance, thereby increasing the risk from driver error [3,4]. Despite the enormous evidence of the relationship between speed and crash risk and severity, the behaviour continues to be pervasive among drivers across the world.

Analysis of the data recorded by the Nigerian federal road safety corps (FRSC) revealed that the rate of speeding-related crashes has been increasing noticeably. The percentage of speeding-related crashes per total number of crashes has increased from 27% in 2010 to 44% in 2017, which is equivalent to a growth of 62.9% [5,6]. Therefore, reducing speeding appears to be a rational way to improve road traffic safety.

Traditional safety measures such as educational awareness, speed humps, and speed enforcement have been effective in speed reduction. However, these countermeasures, tend to only have only local effect, which are limited in time and space in time and space [7,8]. For example, studies have shown that drivers' speed tends to decrease only when they are near enforcement areas, or upon encountering physical speed calming structures, and quickly regain speed once they have passed the intervention sites. Thus, the need to control vehicle speed using technologies from within the vehicle [9]. In recent years, the use of novel and promising in-vehicle systems for speed management have been researched, and new technologies used to reduce excessive and inappropriate speeding in developed nations. One of such strategy that has gained a lot of traction among researchers and policymakers has been the use of Advanced Driver Assistance Systems (ADAS), such as Intelligent Speed Assistance (ISA). An ISA system brings the speed limit information into the vehicle, by helping drivers adapt their speeds to a static or dynamic speed limit. ISA systems function by establishing the position of the vehicle, using the Global Positioning System (GPS) and comparing the vehicle position with a digital road map that contains information of the local speed limits and responds if the speed limit is reached, or exceeded, by giving in-vehicle feedback to the driver.

ISA systems are classified according to their level of configuration and automation, ranging from 'Advisory', 'Warning', or 'Informative' systems, which simply convey information about the current speed

* Corresponding author.
E-mail address: andersonetika@yahoo.com (A. Etika).
Peer review under responsibility of International Association of Traffic and Safety Sciences.

https://doi.org/10.1016/j.iatssr.2020.09.003

Table 1
Description of past ISA studies.

S/N	Country/year	Type of ISA	Effect of ISA
1	Netherland (1999)	Warning (No speed Information)	- The system reduced overall driving speeds by 4 km/h - 10% reduction in the number of time drivers spent above the speed limit.
2	Sweden (1999–2002)	a. Warning b. Advisory c. Limiting	- Mean speed fell by up to 3–4 km/h for each of the systems. - Markedly reduced 85th percentile speed in the range 1.5–7.6 km/h across different road types
3	UK (1999–2000)	a. Advisory b. Limiting c. Intervening	- Reduced mean speeds of up to 7.5 km/h - Up to 11 km/h reduction in 85th percentile speed - Between 1 and 11% reduction in speed violation
4	Australia (2005)	Advisory	- Reduction in mean speeds by up to 1.4 km/h. - Reduction in 85th percentile speeds by up to 2.7 km/h - Reduction in speed violation and speed variability by up to 57% and 1.1 km respectively.

Source: [17][1], [13][2], [18][3], [19][4].

limits to drivers, warning them if the limit is exceeded by audible and visual signs. Systems can also be "Limiting or Intervening"; which physically limits the speed of the vehicle to the current speed limit, by interfering with the vehicle controls, either via an active throttle (reverse pressure on the throttle if the speed is exceeded) or adjusting the engine speed, or braking control, among others.

Unsurprisingly, past ISA studies have revealed positive effects of the system on driver behaviour using different metrics such as speed reductions; reductions in fuel consumption, and volume of emissions, as well as providing safety benefits in terms of reduced fatal and injury crashes. See Table 1 for results from different studies. According to Lai et al. [10], the Power model [11], can be used to assess the benefits of ISA for reducing crash risk and changes in crash severity. For example, Varhelyi [12], estimated a 24–42% reduction in the number of injury crashes if a limiting ISA is fully implemented. Biding and Ling, [13] estimated a 20–25% reduction of injuries crashes and 23–32% in fatal crashes if all vehicles in their study were equipped with ISA. The Malaysian advisory ISA study by Ghadiri et al. [8], estimated a 13% reduction in the number of serious injury crashes, and a 17% decrease of fatal accidents as a result of the system implementation.

However, despite the demonstrated effectiveness of ISA in reducing speeding and the widespread support among networks and road safety bodies, their effect on driving behaviour in low and middle-income countries (LMICs) needs to be measured, since previous trials were mostly carried out in high-income countries (HICs) with similar road-safety cultures and driving styles [8]. According to Lund and Rundmo [14], most drivers in LMICs have higher risk perceptions due to their overall higher exposure to risky and unsafe traffic conditions. Hence, investigating the effect of such a system in LMICs will be interesting giving the different cultural backgrounds, road infrastructures, vehicle types, and the sheer quantity of road crashes and fatalities in this region.

Also, drivers in HICs are more likely to have sufficient education and information in terms of legal speed limits and good road signage, thus, "speeders" would be people who consciously disobey the rules. In contrast, in Nigeria and other LMICs speed awareness education and information are limited, consequently, considerable violations of speed limits in LMICs will be due to lack of knowledge and information of legal speed limits [15,16]. Therefore, the effect of an ISA would be much different in these countries. In Nigeria and LMICs, an ISA will serve to provide speed limit information and warnings that the driver, in many cases otherwise would not have. So, there are potentials for ISA to have bigger effects on speeding behaviour in LMICs. Therefore, the need to control vehicle speed using technologies from within the vehicle would be an issue of interest.

To date there has been no investigation of the effectiveness of ISA in Nigeria, thus, the present study is the first. The study used an experimental on-road approach in which an Advisory ISA was set up using a smart-phone application and its effects on speeding quantified using relevant metrics and statistical methods. The study was carried out from the 5th of November 2016 and 26th of February 2017 in the city of Port-Harcourt, Rivers State in Nigeria.

2. Materials and methods

2.1. Participants

Participants in this study were recruited from a fleet company in Port-Harcourt as part of a wider study. In all 20 participants, all men (demonstrating that fleet and commercial driving is an exclusively male-dominated sector in Nigeria), aged 35–60 years, were included in this study. The 20 participants were among the initial 150 that had shown interest in participation. Participants had an average annual mileage of about 10,000 km. Ethical approval for the recruitment and test protocols was received from the Research ethics committee of the University of Leeds (Ethics reference: AREA 16–011) as part of a larger research work [42].

2.2. Experimental design and procedure

The research was conducted in two phases involving a within-group experimental design of 20 participants. Drives were done in real traffic conditions, and along a 46 km long test route in Port-Harcourt, Rivers State, Nigeria. The test route is a 2-lane major dual-carriage road linking the city of Port Harcourt to the airport in Omagwa, a growing suburban area in River State (see Fig. 1). The test route had the following features; varying speed limits of 50 km/h, 60 km/h, and 80 km/h, urban roads with mixed traffic, a moderate number of pedestrians, and rural highway sections. The route was aggregated into 10 different segments with a new segment defined every time there was a change in speed limit. The choice of this route was based on the suggestion of the Federal Road Safety Corps Port-Harcourt Command (the agency responsible for road traffic safety in Nigeria) and was underpinned on the following factors: free-flowing traffic conditions, availability of different speed limit zones and signage and high traffic crashes and fatalities. A prior speed survey showed a moderate speed limit violation by the general driving population.

Participants drove a rented Automatic transmission Toyota Camry 2000 Model all through the study. The ISA system was a GPS based speed limit warning application designed and developed by Sygic Business Solutions and downloaded on an iPhone 8 plus (display 5.5-in. display with a 1920-by-1080 pixel resolution at 401 ppi). The Human Machine Interface (HMI) for the system, employed a visual display on the phone screen showing the current speed limit, the vehicle speed, and a digital map. Speeding (defined as exceeding the speed limit by 1 km/h or more) was accompanied by the main speed rondel flashing red until the participant reduced their speed to or below the recommended speed limit. For the audio-visual components, the flashing rondel was accompanied with continuous beeping alert or voice alert, synchronized with the flashing, until speeding stopped. The ISA

Fig. 1. Test drive route.

application automatically updates to a new speed limit 5 s after entering a new speed zone. See Fig. 2 for a description. The participant data was logged using a hand-held 1 Hz GPS logger and downloaded after every drive.

The first phase (baseline) of the study involved participants' driving all through the test route without the ISA system and was meant to reflect participants normal driving behaviour. The second phase (ISA) involved participants driving with a smartphone installed with the ISA application mounted on the windscreen of the car and turned on. Participants were also instructed to drive as they would in their cars and obeying traffic rules. Before the on-road drives, all participants were briefed in general terms of the nature of the smartphone application which is the provision of a visual and auditory speed limit information of every road section and more specifically about the study being for academic purposes only. Participants were neither given encouragement nor discouragement to take any notice of what they were seeing or hearing from the application.

General questionnaires asking about participants' personal information were given out. All participants signed the study consent forms. On completing the ISA drive, each participant received a sum of N10,000

Fig. 2. Visual alerts of the ISA system, GPS logger, and system set up in the vehicle.

(Ten thousand naira only the equivalent of US$20) in appreciation for taking part in the study.

2.3. Analysis method

To ensure the analyses were not biased towards certain speed observations, Lahrmann et al. [20], propose that only speed observations where the driver speed choice is not limited by a car ahead, a curve, a signalised intersection, or being stationary, should be included in the analysis. However, GPS log files do not show this kind of observation, and no cameras or experimenter were present to monitor participants during drives in other to minimise observer effect[1] which according to Spano [21] could influence the behaviour of the participants by serving as an intervention. The researchers decided to exclude speed data from the analysis in cases where it can be reasonably assumed that there is no speed choice or speed choice is not free [22]. Different thresholds have been used by past studies to identify valuable trips and movement with the threshold varying mainly by the characteristics of the local activities [23]. For the current study, cases of no speed choice or speed choice not being free are defined as stops, speed from random errors, and speed from systemic errors). The thresholds include (i) Exclusion of speed data below 1 km/h. Agerholm et al. [24] argue that such data though intuitively valid can often introduce undue weights to the data stream, especially when vehicles are stopped or moving slowly in congestion. (ii) Exclusion of speed data above 150 km/h. Though very rare (only 2 GPS points), it was assumed that such data were outliers resulting from GPS error. (iii) removal of all data in areas without a valid speed limit (e.g. where the speed limit shown by the application did not correspond to the legal speed limit of the section). Approximately 5% or 6, 800 GPS points of the data were excluded from analyses. For the current study, all observations were weighted in proportion to the distance travelled between two observations using the formula below.

$\bar{x} = \sum_{i=1}^{n} vi * \frac{li}{\sum_{i=1}^{n} li}$	$\bar{x}$=Weighted speed V_i = Speed over distance l_i l_i = The distance travelled with the speed vi

To study the behavioral effects from using ISA, the following parameters were examined: Speed distribution, Mean Speed, Speed Deviation, 85th Percentile Speed, Percentage distance travelled above the speed limit (PDAS), and Safety estimation.

A series of paired sample t-test was carried out to assess the impact of the ISA application on drivers' speed choice across the different speed limit zones. However, due to the non-normality of the variable; Percentage distance travelled above the speed limit (PDAS), the non-parametric Wilcoxon sign rank test was used.

3. Results and discussions

3.1. Effect of the system on speed distribution

Driving with the ISA application showed a distinctive effect in translating the cumulative speed distribution across all the speed zones when compared with the baseline period. According to Comte [25], translation is where the shape of the distribution remains the same but is shifted to either downwards or leftward in terms of speed. The speed distribution showed participants' drove close to the speed limits (see Fig. 3). The 50 km/h speed zone had the largest speed distribution which may be due to the possibility of interaction with pedestrians and other road users. Also, results from this study agree with findings in [26,27] where the speed at which drivers drove over the limit, particularly the high-end speeds exceeding the limits were curtailed by the intervention. On the other hand, in line with the results of past ISA studies [25,28], the intervention had minimal effect on the lower ends of the distribution, which represent speeds that are lower than the speed limit [28]. Also, the ISA did not encourage participants to gain time (from the perceived lost time) by attempting to drive closer to the speed limits, i.e. no negative behavioral adaptation was observed.

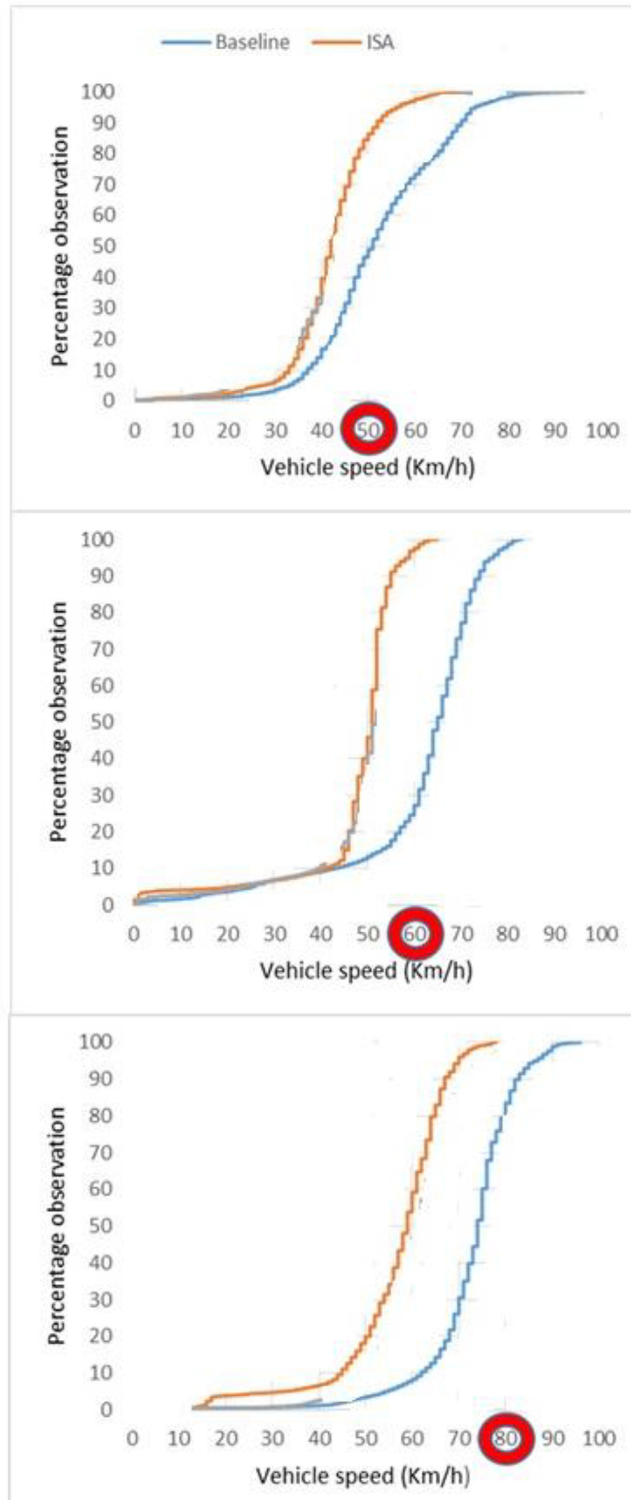

Fig. 3. Cumulative speed distribution curves for all speed zones.

[1] Observer Effect: A form of reactivity in which subjects modify an aspect of their behaviour, in response to their knowing that they are being studied [19].

Table 2
The system effect on speeds for the three segments.

Indicator	Speed zone	Mean			Paired sample *t*-test
		Baseline (km/h)	ISA (km/h)	Change (km/h)	
Mean speed	50	53.2	42.7	−10.5	t (19) = 13.62, p < 0.001
	60	62	48.6	−13.4	t (19) = 11.00, p < 0.001
	80	73.6	58.6	−15	t (19) = 13.76, p < 0.001
Standard deviation	50	5.7	4.4	−1.3	t (19) = 3.47, p < 0.001
	60	10.7	6.8	−7.11	t (19) = 4.19, p < 0.001
	80	5.6	4.3	−1.3	t (19) = 5.12, p < 0.001
85th percentile speed	50	58.3	46.1	−12.2	t (19) = 16.56, p < 0.001
	60	68.9	52.5	−16.4	t (19) = 14.73, p < 0.001
	80	77.8	61.9	−15.9	t (19) = 14.64, p < 0.001

Statistically significantly different from base condition (a = 0.05).

Although the current study did not investigate the effect of the ISA system on visual distraction, previous studies with similar apps have not found any evidence of visual distraction from the use of such apps [29]. However, visual displays and auditory alerts from the ISA app are capable of increasing driver workload by their presence [30].

3.2. Effect of the system on driving speed

3.2.1. Mean speed

Paired-samples *t*-test revealed that for all the speed zones: 50 km/h, 60 km/h and 80 km/h, the Advisory ISA application brought about a statistically significant reduction in the mean speed, (50 km/h: t (19) = 13.62, $p < 0.001$; 60 km/h: t (19) = 11.00, p < 0.001; 80 km/h: t (19) = 13.76, $p < 0.001$. Table 2 shows that the mean speed was mainly reduced by up to 15 km/h for 80 km/h speed zone, where the speed was the highest. The reduction for speed zone 50 km/h and 60 km/h was 10.5 and 13.4 km/h respectively. Past advisory ISA studies [8,17,20,27] have shown mean speed reduction between 1 and 5 km/h, depending on road type. The reductions in mean speed revealed in this study are somewhat higher than past studies, but comparable, given the different circumstances (driving context and environment). One likely explanation is that the mean speed of drivers' in the current study at baseline was relatively higher than the speed limit (50 km/h and 60 km/h speed zones). Therefore, there may have been a relatively higher opportunity for the ISA system to affect their speeds given that the drivers were already travelling at higher speeds.

3.2.2. Speed deviation

The results show a reduction in standard deviation across all speed zones at $p < 0.001$ level, and this effect is largely due to a reduction in the high-speed end of the distribution. The reduction in speed deviation was up to 1.2 km/h in both 50 km/h and 80 km/h speed zones and, 3.96 km/h in the 60 km/h zone. The standard deviation of speed shows the range of speed within a road segment, with small margins indicating that most of the traffic is driving at a similar speed [31]. Past studies have shown that the amount of speed variation influences the crash rate, with a higher variation of speed resulting in more crashes. These findings are similar to past on-road studies examining the effect of ISA warning systems on the deviations of speed (17, 8, 24] which found speed deviation reductions of up to 3.8 km/h.

3.2.3. 85th percentile speed

The results also showed a statistically significant reduction in the 85th percentile speeds across all speed zones at $p < 0.001$ level. The reduction in the 85th percentile speeds was up to 12.2 km and 15.9 km/h in speed zone 50 and 80 km/h respectively. The largest decline of up to 16.4 km/h was recorded in the 60 km/h speed zone. The 85th percentile speed serves as a good indicator, of speed changes from interventions, by eliminating any bias from either idling or driving in congestion. The 85th percentile speed is a metric used for setting up speed limits of road sections and is used in highway engineering, either for design, or safety purposes. Previous studies have found the advisory ISA particularly effective in reducing the highest speeds (by up to 5.5 km/h) depending on the speed zone (32, 8]. However, like mean speeds the relative higher reductions in this study (up to 21% reduction) can be attributed to the drivers' in the current study driving at a relatively higher end of the speed distribution, at baseline, than those in previous studies.

3.2.4. Percentage distance travelled above the speed limit (PDAS)

The variance in driver's speed limit violations before and after the use of the ISA application was accounted for by using the percentages of the total distance driven 1 km/h or more above the speed limits at the different speed zones. Studies by [20,27,33] have all found this indicator as a better way of expressing the effectiveness of speeding interventions rather than just overall speed reductions. Results revealed a significantly difference from baseline level levels across all speed zones; 50 km/h: z (19) = −3.920, $p < 0.001$, 60 km/h: z (19) = − 3.922, p < 0.001, and 80 km/h: z (19) = − 3.410, $p < 0.001$. Speed limit violation was more prevalent in the baseline phase, the highest amount of speeding per distance occurring in the 60 km/h zone (83.01%). There was a 100% reduction in the distance travelled above the speed limit in the 60 km/h and 80 km/h speed zones. According to Agerholm et al. [24], drivers tend to show higher acceptance of urban speed limits than rural or motorway speed limits, which in part can explain this finding as the 60 and 80 km/h speed zones were both off urban areas. The complete elimination of speed limit violation by the application could also be attributed to the "novelty effect"[2] (i.e. the participants were experimenting to find out how the ISA systems worked) rather than the participant intending to break the speed limit.

The results though higher, are in line with those of [20,27] who in their studies found ISA to reduce speeding by up to 44 and 70.5% respectively. (See Fig. 4 and Table 3).

3.3. Road safety estimation

The effect of the system on safety was estimated using coefficients from the power model [34]. Results from Table 4 shows the estimated effect of ISA on serious-injury crashes, based on reductions in the mean speed, to be of the range 44–47% and a 59–63% reduction in fatal crashes. Estimated safety savings from previous studies [8,32,35] were in the range of 5.3–23% for both serious-injury and fatal crashes. The results from the current study appear to be higher than past studies, and the possible reason could be that the Power Model was calibrated

[2] Novelty effect here is the tendency for performance to initially improve when new technology or treatment are introduced [36].

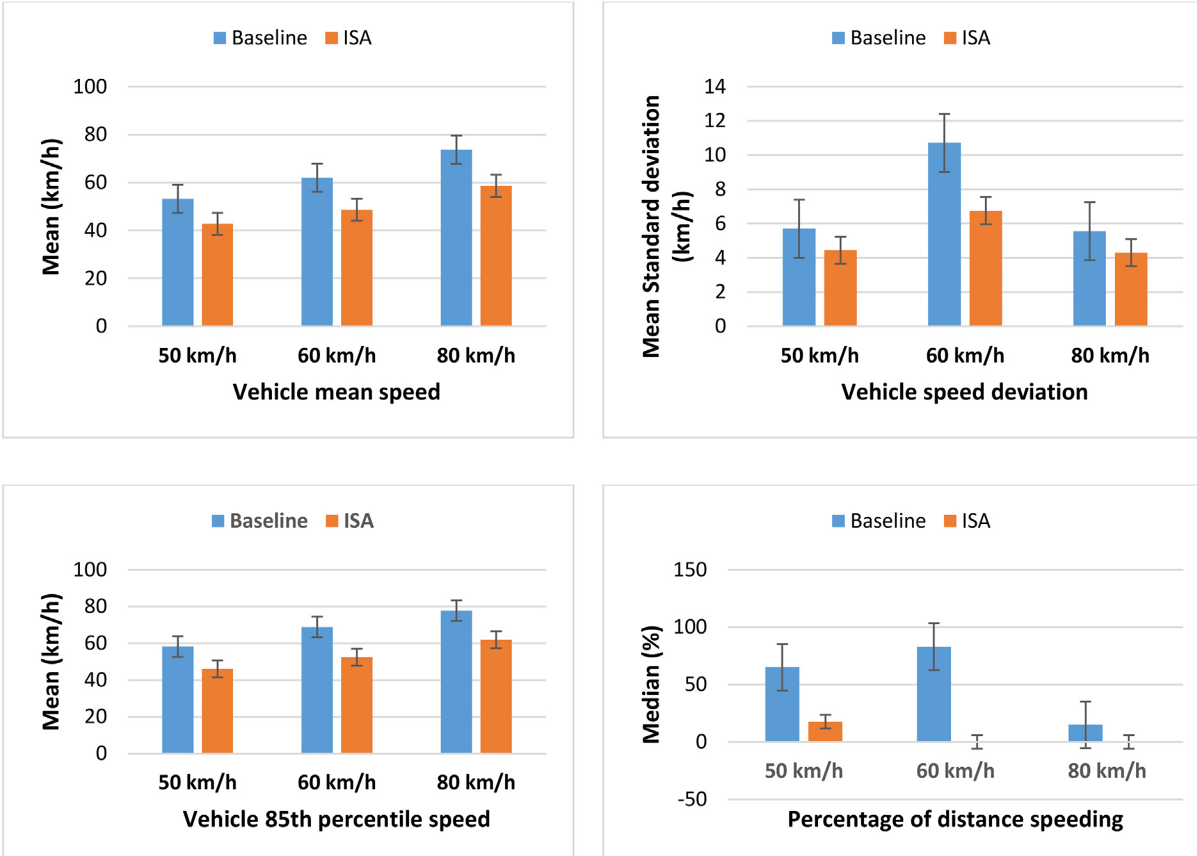

Fig. 4. System effect on participants across all speed zones.

Table 3
Percentage distance travelled above the speed limit.

Indicator	Speed zone	Total distance of speed zone (km)	Median percentage distance speeding above the limit (%)		Paired defences
			Baseline (%)	ISA (%)	
PDAS	50	16.8	65.1	17.7	$z\,(19) = -3.920,\ p < 0.001$
	60	15.3	83.01	0	$z\,(19) = -3.922,\ p < 0.001$
	80	14	14.9	0	$z\,(19) = -3.410,\ p < 0.001$

Statistically significantly different from base condition (a = 0.05).

for high-income countries, which have a higher quality of roads and infrastructure, and better traffic laws. Hence, its application in lower- and middle-income countries known for higher burdens of road traffic crashes and fatalities, lower seat belt wearing, and less protective vehicles might differ. There is a likelihood that the exponents might be higher, therefore the Power Model will predict that a crash at a given speed is more likely to result in severe outcomes in developing nations (bringing higher estimates), as opposed to developed nations.

Table 4
Estimates of crash savings by severity.

Speed Zone (km/h)	Mean Speed (km/h)		Expected decrease in the number of serious injury crashes = $(1-(V_2/V_1)^{2.6}) * 100$	Expected decrease in the number of fatal crashes = $(1-(V_2/V_1)^{4.1}) * 100$
	V_1	V_2		
	Baseline	ISA		
50	53.2	42.7	44%	59%
60	62	48.6	47%	63%
80	73.6	58.6	45%	61%

4. Conclusions

Reducing speed limits violations continues to be a major concern of road safety bodies around the world. The Intelligent Speed Assistant (ISA) an in-vehicle system that brings speed limit information into the vehicle, by helping drivers adapt their speeds to a static or dynamic speed limit, has been widely researched worldwide, particularly in high-income countries. However, despite the positive results from past studies, their effect on speeding behaviour in low and middle-income countries (LMICs) has received little attention.

This study evaluated the impact of a smartphone-based warning ISA on driver speeding behaviour and their potential to improve road safety among a sample of Nigerian drivers. Several indicators that show aspects of speeding behaviour were investigated at an aggregate level; Mean speed Standard deviation, 85th percentile speed, and Percentage distance travelled above the speed limit (PDAS). Also, the effect of the system on road safety was investigated.

The findings showed the potential of the system in influencing drivers' choice of speed positively. This was evident in the aggregated analysis of speed behaviour with significant reductions across all the metrics used and across all speed limit zones used relative to baseline levels. Also, results showed possible large road safety benefits in terms of reduced serious-injury and fatalities crashes from using the system. The reductions in the current study though higher than past studies are comparable, given the different circumstances (driving context and environment). The complete elimination of speed limit violations by the ISA application in the 60 and 80 km/h speed zones could also be attributed to the “novelty effect”. These drivers may have been using the ISA system as an experimenting function rather than intending to break the speed limits. The findings in the current study showed that the Power Model used in calculating the road safety benefits may be better operationalised in HICs than LMICs. This may be related to the fact that the model was calibrated mostly using data from HICs with different a driving environment and infrastructure from LMICs.

There were no observed negative effects on driver speeding behaviour from the use of the system.

The following conclusion can thus be drawn. With over 90% of the vehicle fleets in Nigeria consisting of imported second-hand vehicles with an average age range of 15–20 years [37,38], the speed warning app will provide an important means of improving driver safety in countries like Nigeria with an older vehicle fleet (without manufacturer-installed in-vehicle driver assistance systems. Also, considering the “limited” resources available for road safety interventions in Nigeria, and most developing nations, it will be sensible to focus more on individually tailored cost-effective solutions like the one used in this study. The ISA application used in the current study is relatively affordable (can easily be downloaded from app stores), and with the increase in the use of smartphones and mobile internet by Nigerians, such an intervention could serve as a socially cost-effective, user-friendly, and effective speed management tool as an alternative and/or complement conventional interventions. Another advantage of the system is the continuous speed limit information and feedback the driver receives while in the vehicle as against the conventional speed limit signs. Although the use of the system is voluntary (the driver can easily turn it off and might incur “longer” travel time), it is worthy to note that the time-saving bias from not using the system will be gained from violating the speed limits.

The ISA application can also serve as a reinforcement for speed limit awareness as a large percentage of the driving population obtain their licenses without prior training in driving schools or pre-license tests [16], and thus lack knowledge of legal speed limits. Also, most Nigerian roads either do not have speed limit signage or available ones are either defaced or worn out [15] However, Chorlton and Conner [39] argue that the underlying psychological factors such as beliefs and attitudes to speeding can be changed, or modified, with the provision of continuous speed limit information, or by imposing vehicle control, to reduce speed. Thus, experience with ISA may serve to modify drivers' beliefs relating to perceived gains from speeding and producing positive cognitive changes [40]. According to Langer, et al. [41], if the use of such an application increases driver's intention to comply with speed limits and the application is readily available subsequently, then acceptance is likely.

In conclusion, whilst the system offers potential speed reduction (established through the statistical significance of the speed measures) and estimated road safety benefits, caution is required in the interpretation of the findings of this research due to the small sample size and lack of long-term interaction, and experience with the system.

Further studies with a larger sample size will be needed to test the long-term effect of the intervention on drivers' behaviour, to establish if effects observed in the current study were not sample due to novelty effect. Also, the potential visual distraction from mobile use while driving would have to be weighed against road safety benefits.

Declaration of Competing Interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Acknowledgement

Appreciation to the Cross River University of Technology, Calabar, Nigeria(through its Tertiary Education Trust Fund intervention), and the Institute for Transport Studies, University of Leeds, UK for funding my Ph.D studies of which this project is part of.

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