Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.6, No.5, 2014
www.iiste.org

Road user safety on the National Highway 1 (N1-Highway) in Accra, Ghana

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Abstract
Road Traffic Crashes (RTCs) are one of the leading causes of premature deaths in Ghana. Recently, after the rehabilitation of a very critical link on the N1-Highway in Accra, RTCs have soared. The prevalence of traffic injuries and fatalities has attracted the attention of both, road safety professionals and policy makers. Road user behavior has been established to contribute significantly to RTCs. The object of this study was therefore to assess the attitude of both pedestrians and motorists in relation to compliance with traffic safety regulation on the N1-Highway. Covert but unobstructed spot speeds studies were undertaken at accident-prone location on the highway with posted speed limit of 70 km/h. Besides, driver compliance with traffic signal regulations and pedestrian road crossing behavior were also assessed. The 85th percentile speeds realized was 78.2 km/h, which was in excess of the posted speed limit. In all, 42,298 motorists were registered, of which 0.3% was observed run the red traffic lights during the day on the highway. More than 1 in 5 of the 105,151 pedestrian observed jaywalked. Road user behavior undoubtedly, presents a significant road safety challenge on the N1-Highway. Road user education and training must be pursued and sustained, alongside strict enforcement of traffic safety regulations to modify road user, while considering legislation to regulate pedestrian behavior in traffic for safer travels.
Key words: Road user behavior, Excessive speed, Pedestrians, RTCs, N1-Highway, Accra, Ghana

1. Introduction

Transportation is the lifeblood of every modern society. Efficient and safe mobility of people, goods, and services ensures a thriving economy and improves quality of life. Road transport particularly, is the predominant mode of transport and thus the mainstay of most low-and-middle income countries, as other modes of transport are either underdeveloped or yet to be explored. In Africa, it accounts for 80% and 90% of goods and passenger traffics respectively (United Nations Economic and Social Council (UNESC), 2009).

Transport is one of the key sectors that play critical roles in achieving the goals of poverty eradication and sustainable development (UNESC, 2009). The condition and operational capacities of transportation facilities are thus very critical in Africa's poverty reduction agenda, especially given that the continent is one of the poorest, though it is endowed with abundant mineral and natural resources. According to the UNESC (2009), Africa needs to invest about US$ 40 billion annually in building new infrastructure and another $40 billion for maintenance and operation of existing infrastructure in order to achieve its goals of poverty reduction and sustainable development.

In light of this recommendation the government of Ghana (GoG) in her bid to stimulate economic growth, secured funding from the Millennium Challenge Cooperation (MCC) of the United States of America, to embark on the construction of a critical link on the National Highway 1 (N1-Highway) in the heart of Accra, to accommodate the soaring local, national, and international traffic.

Traversing more than 500 kilometers of Ghana's coast, the N1-Highway, as shown in Figure 1, does not only represents a regional thoroughfare on the Trans-West Africa Highway System, but also an economic and trade lifeline (MCC, 2012).

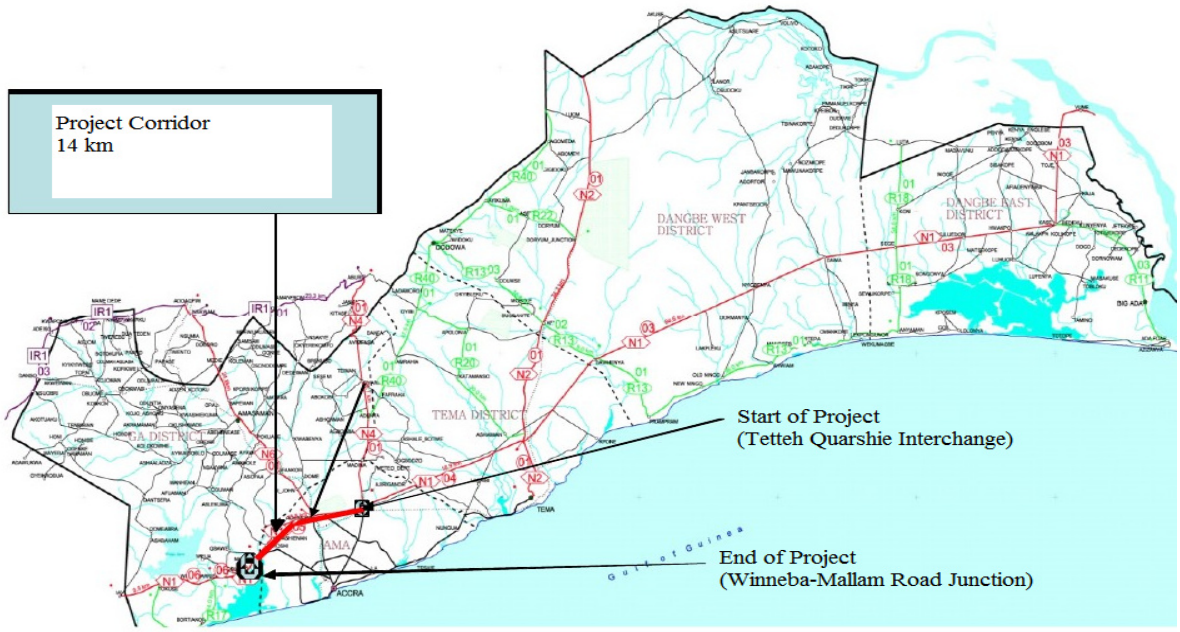

Figure 8: The Road Map of Greater Accra Region
Source: http://mida.gov.gh, 2013

It links Ghana's international airport and two deep-water sea-freight ports in Tema and Takoradi, to key agricultural production zones (MCC, 2012).

As an emerging economy and a trade hub for much of West Africa, the operational efficiency of the N1-Highway, particularly the 14-kilometer two-lane undivided stretch between Tetteh-Quarshie Interchange and Mallam Road Junction (TQM) in the Accra Metropolis, is paramount to Ghana's economic growth, and the rest of the West Africa sub-region.

Sadly, this critical link has seen very little infrastructural expansion to accommodate the exponential growth in traffic, in the Accra Metropolis since the 1960s. Handling up to 30,000 vehicles per day, the 14-kilometer two-lane undivided stretch of the N1-Highway, was often congested and lacked the operational capacity required to serve such high volumes of national, transnational, and local traffic (MCC, 2012). The unsightly, odious, traffic jam culminated in excruciating travel times and increased transportation and vehicle operating costs for agricultural and other sectors. This phenomenon undoubtedly, imposed huge constraints on Ghana's economy.

In order to remedy the situation, the GoG under the Transport Project of the Millennium Challenge Account Ghana programme (MCA) with funding from the MCC, embarked on a rehabilitative programme of this bottleneck. The project commenced in December 31, 2008 and completed in January 31, 2012 at a cost of US$55.7 million (The Daily Guide, 2012).

The recently completed highway now boasts a six-lane, divided thoroughfare with four overpasses, one elevated circle interchange, street lighting, drainage, bus stops, extra-wide sidewalks with graded ramps, pedestrian walkovers, and stoplights at all major intersections (MCC, 2012).

Though, the refurbished highway has enhanced mobility in the Accra Metropolis, travels are, however, riddled with safety challenges. Available crash statistics indicates that, barely 11 months after its inauguration, 389 RTCs occurred on the TQM, between the period, February 14, 2012 and December 31, 2012, registering 52 fatalities and 284 injuries. Besides, 112 pedestrians were run-over by motor vehicles within the same period (ExposeGhana.com, 2013). This is certainly outrageous and the antithesis of the overall purpose of the rehabilitative programme. This unfortunate development presents a huge socio-economic impact on families, communities, and the nation as whole. The economic impacts of RTCs are enormous. Estimate has it that, the economic loss due to RTCs is equivalent to 1.6% of Ghana's Gross Domestic Product (Building and Road Research Institute, 2006). The quest for enhanced mobility certainly, should not be attained at the expense of human lives. Road user behavior has been established to contribute significantly to RTCs. The object of this study was therefore to assess the attitude of both pedestrians and motorists in relation to compliance with traffic safety regulation on the N1-Highway.

2. Materials and Methods

The Greater Accra Region is one of the ten regions in Ghana and has a population of 4,010,054, with majority, 46.1% (1,848,614) of the population concentrated in the Accra Metropolis (Ghana Statistical Service, 2010), the capital city of Ghana. As a trade hub for much of West Africa, the city is most often inundated with a plethora of vehicular traffic. The TQM, an integral part of daily economic activities in the city, lies entirely in the Greater Accra Region, and traverses a highly urbanized corridor. It serves as a bypass to the Central Business District (CBD) of Accra for road users to and from Central, Western, and Eastern Regions of the country (Millennium Development Authority, 2010).

It is well established that, excessive speeding, driving under the influence of alcohol and drugs, jumping of red traffic lights, and fatigued driving are but a few of the primary accident risk factors. In addition, poor road use by pedestrians such as jaywalking has been observed to elevate RTCs. In light of the recent spate of RTCs on the TQM, it is imperative to assess a couple of these road user behaviours attributable to RTCs in the real world settings. Spot speed studies, running of red traffic lights by motorists, and pedestrian jaywalking, were therefore observed during the study, to gauge the attitudes of road users in accessing the refurbished highway facility.

Spot speed studies particularly, were conducted to evaluate motorists' compliance with posted speed limits. In the studies, radar meter was used. In order to avoid tainting the collected data, covert but unobstructed observations were made. Field observations were made at Lapaz, a high accident-prone location with a posted speed limit of 70 km/h, on the TQM in a benign weather condition. Inclement weather conditions, such as rains, may culminate in slower observed speeds, which may in turn have effect on speed percentiles (Centre for Transportation Research and Education, 2009). Spot speeds measurements were made on Wednesday, 8 May 2013, during the off-peak period, as free-flow conditions were necessary for accurate observations. Random off-peak measurements were made and recorded from 7:00 am-7:55 am. The period was selected to capture the morning travels to work and school. In spot speed studies, Ewing (1999; as cited in Centre for Transportation Research and Education, 2009) recommends a minimum sample size of 50, and preferably 100 vehicles. In all, 116 vehicles were recorded in the studies.
Furthermore, motorists were observed for strict compliance with traffic signal controls. In all, four automatic traffic lights locations were identified on the TQM. Observers were positioned at these traffic lights (T). These locations were *Barnyard (T1), Kwashieman (T2), Nyamekye junction (T3), and La-paz (T4)* to screen and record motorists running red traffic lights. Observations were made from 7:00 am-6:00 pm, consistently for a period of one week.
Finally, owing to the significant proportion of pedestrian fatalities on the N1-Highway, pedestrians were observed for crossing compliance. Observers were positioned at the traffic lights locations and in-between pedestrian footbridges erected across the highway, to observe and record pedestrian crossing behavior from 7:00 am-6:00 pm, for a period of one week.

2.1 Data Analysis

All data analyses were conducted using Microsoft Excel spreadsheet. The 50^{th} and 85^{th} speed percentiles were calculated from the weekday off-speak observed spot speeds data, in order to evaluate compliance with speed limits. Equation (1) was used to achieve this end (Centre for Transportation Research and Education, 2009).

$$S_D = \frac{P_{D-}P_{min}}{P_{max-}P_{min}} (S_{max} - S_{min}) + S_{min} \qquad (1)$$

Where S_D = Speed at P_D; P_D = Percentile Desired; P_{max} = Higher cumulative percent
P_{min} = Lower cumulative percent; S_{max} = Higher speed; S_{min} = Lower speed.

Finally, the proportion of motorists breaching red traffic lights, and pedestrian jaywalking were computed for analysis and discussion.

3. Results

3.1 Spot Speed Studies on the N1-Highway

After almost an hour of random spot speeds observations, 116 vehicles were screened for speed limit compliance of 70 km/h. Table 1 provides details of the field measurements.

Table 1: Spot Speed Study Distribution Table on the N1-Highway, Accra

Speed (km/h)	Motorcycles	Passenger cars	2-Axle Vehicles	3-Axle Vehicles	Total Frequency of Vehicles	Cumulative Frequency	Cumulative Percent	Speed Percentile
	Frequencies							
65	1	3	2		6	6	5%	
67	1	1		1	3	9	8%	
68	1	3			4	13	11%	
69			2		2	15	13%	
70	2	1	5		8	23	20%	
71	1	4	4	1	10	33	28%	
72	3	4		4	11	44	38%	
73	2	7	3	1	13	57	49%	50th Percentile
74	2	1		2	5	62	53%	
75	4	3	2	2	11	73	63%	
76	1		5	1	7	80	69%	
77	1			1	2	82	71%	
78	1	4	6	4	15	97	84%	85th Percentile
79	2	2	2		6	103	89%	
80	1	2	2	2	7	110	95%	
81		1	1		2	112	97%	
82				3	3	115	99%	
83			1		1	116	100%	
Total					116			

Source: From author's field study, 2013

By applying Equation 1, the 50th and 85th percentiles speeds of the traffic stream were 73.25 km/h and 78.2 km/h respectively.

3.2 Motorists Compliance with Traffic Control Devices

Motorist behavior, in respect of compliance with traffic control signals were assessed, as it is cardinal to safety in the road environment. In all, 42,298 motorists were screened at the traffic lights. Of these, 116 (0.3%) were observed breaching the red traffic signals (Table 2).

Table 2: Motorists compliance with Traffic Lights on N1-Highway, Accra

	No. of vehicles observed at the various Traffic Lights Locations					No. of vehicles observed run the Red Traffic Lights				
	T1	T2	T3	T4	TOTAL	T1 n (%)	T2 n (%)	T3 n (%)	T4 n (%)	TOTAL
	8461	14804	9728	9305	42298	30 (25.9)	31(26.7)	27(23.3)	28 (24.1)	116

Source: From author's field study, 2013

Of the 166 traffic lights infractions, the Kwashieman Traffic lights (T2) was the most heavily violated, with approximately 27% of the motorists running the red traffic lights, followed by 26% at the Barnyard traffic lights (T1), 24% at the La-paz traffic lights (T4), and 23% at the Nyamekye traffic lights (T3).

3.3 Pedestrian road use behaviour

Responsible use of a transportation facility by all road users enhances road safety. In view of this, pedestrians were observed for crossing compliance of the N1-Highway. As whole, 105,151 pedestrians were clearly observed and recorded crossing the highway (Table 3).

Table 3: Pedestrians crossing behaviour at various Locations on the N1-Highway, Accra

	Using on-street pedestrian crossing at Traffic Lights locations (T)				Using Footbridges (FB)			Pedestrian Jaywalking			Total
	T1	T2	T3	T4	FB1	FB2	FB3	FB1	FB2	FB3	
	10738	14973	17211	18734	6433	6704	5709	10404	6643	7602	105,151
Total n (%)	61656 (58.64)				18846 (17.92)			24649 (23.44)			

Source: Field observation, 2013

More than one-half (59%) of the pedestrians crossed the highway using the pedestrian crossing at Barnyard (T1), Kwashieman (T2), Nyamekye (T3), and La-paz (T4) traffic lights. Approximately 18% of them used the pedestrian footbridges at Kwashieman (FB1), Nyamekye (FB2), and Flat Top (FB3), in crossing the highway, while more than 1 in 5 pedestrians jaywalked. It is patent that, of the two designated and sanctioned locations for pedestrians to safely traverse the high-speed highway, the pedestrian footbridges were the least patronized.

3. Discussions

Roads, either newly constructed or rehabilitated are assigned varying speed limits along their sections to ensure safe and efficient operation of motor vehicles. The 85th percentile of speeds is customarily used in evaluating or recommending posted speed limits (Homburger *et al.*, 1996; as cited in Centre for Transportation Research and Education, 2009), as it is normally assumed, the maximum safe speed that can be maintained at a given section of a roadway, under favourable weather conditions.

The spot studies revealed 50th and 85th speed percentiles of 73.25 km/h and 78.2 km/h respectively. A 5-mph (8 km/h) rule of thumb is used to determine whether the 85th percentile of speed is too high compared with the posted speed limit, and if it is 5 mph (8 km/h) or more above the posted speed limit, the situation is evaluated (Centre for Transportation Research and Education, 2009). The 85th percentile of speed in this study was in excess of the statutory posted speed limit by 8.2 km/h. This suggests that, motorists are engaged in over speeding on the rehabilitated N1-Highway in Accra. This is an illegality, which must be addressed through sustained driver education and enforcement programmes.

This negligent driving behavior emanating from an improved road quality, though counterintuitive, is not exclusive to the N1-Highway in the capital city, Accra. Earlier research indicates that, after the rehabilitation and expansion of most road transport infrastructure in the Ashanti region of Ghana, excessive vehicular speeds were recorded on these roads (Afukaar & Agyemang, 2006). A plethora of factors may be attributable to this traffic safety regulation infraction. With the improved road condition, combined with relatively adequate road space, stemming from the dualization of the single-undivided-carriageway to a three-lane dual carriageway facility, commercial vehicle operators in their bid to maximize daily profits, over speed to reduce the round trip time, as the profit margin of a typical commercial vehicle operator in Ghana, is primarily contingent on the number of roundtrips per day. In the same vein, other motorists also take advantage of the less traffic congestion condition to engage in excessive speeds to meet their daily socio-economic needs, with impulsive ones exacerbating the situation. Efforts should be directed at reversing this worrying trend.

Low journey times are exceedingly desirable (Taylor et al., 2000) not only for drivers, but also for passengers. Unfortunately, low journey times are synonymous with high vehicular speeds with adverse effects. Excessive speed have well been established to increase the likelihood and severity of RTCs. For instance, in a study to investigate the impact of traffic speed on the frequency of RTC, Taylor et al. (2000) found out that in a given situation, higher speeds mean more accidents, and the higher the speed the more rapidly does accident frequency rise with increases in speed. In general, statistically, over speeding often contributes to as much as up to one third of fatal accidents and an aggravating factor in all accidents (OECD, 2006; as cited in Howard & McInerney., 2010). In Ghana, for example, excessive traffic speeds accounted for 26% road traffic fatalities in 2010 (Building & Road Research Institute, 2011). Inordinate traffic speeds thus explain the prevalence of RTCs on the N1-Highway.

At higher speed, the effects of failing to anticipate oncoming hazards in good time and of vehicle handling errors are magnified (Howard & McInerney., 2010). Again, as speed increases, the drivers' reaction distance also increases, and so does the breaking distance needed to stop safely after sighting a harzard on the roadway. The breaking distance, among others is dependent on the condition of the vehicle's tyres and brakes. Excessive speed, coupled with high porportion of road-unworthy vehicles on Ghana's roads, may have contributed

significantly to RTCs on the N1-Highway in Accra. Road worthy vehicles should be encouraged on our roads, coupled with the installation of high-speed cameras to ensure compliance with speed limits.

Speed-related RTCs have been established to be associated with traffic injury severity. In the event of a RTC, the severity of traffic injury increases exponentially with vehicle speed by a factor of four for fatalities, three for serious injuries, and two for casualty crashes (Howard & McInerney., 2010). The extent at which the human body can tolerate RTCs is limited. Even the best-designed motor vehicle on the road today provide crash protection currently up to 70 km/h for properly belted occupants in frontal impacts and 50 km/h in side impacts (Tingvall & Haworth, 1999). Sadly, in Ghana, most motor vehicles are unequipped with seat belts, and significant proportion of occupants do not belt up even if vehicles are fitted with one (Densu & Salifu, 2013). The excessive traffic speeds and low belt use among vehicles occupants explains the severity of traffic injuries on the N1-Highway in the event of RTCs.
The safety of vulnerable road users such as pedestrians is a key consideration in the design and construction of any transportation facility. To this end, pedestrian footbridges were erected to ensure safe crossing of the highway. This study, however, revealed that, footbridges were the least patronized, with only 18% of pedestrians using them. The low patronage raises concerns as regards the accessibility of this pedestrian facility. If pedestrians have to overcome long walking distances to access a footbridge, then they are more likely to explore alternative routes that present relatively shorter walking distances to enable them cross the highway even at the peril of their lives. Findings from studies in Brazil, Mexico, and Uganda suggest that, in preference to walking long distances to use overpasses, pedestrians will create their own routes through the traffic, placing themselves at increased risk of injury and fatality (Hijar et al., 2003; Forjuoh, 2003; Mutto et al., 2002; as cited in Ameratunga et al., 2006).

The adverse effect of pedestrian aversion for pedestrian footbridges is evident in the prevalence of non-crossing compliance. More than 1 in 5 pedestrians risked their lives accessing this wide highway facility using unmarked crossing. Research indicates that, while pedestrians will survive RTCs at traffic speeds of 30 km/h and below, most would be killed as traffic impact speeds increase to 50 km/h (OECD, 2006; as cited in Howard & McInerney., 2010). Jaywalking obviously predisposes pedestrians to RTCs, and may have partly accounted for the incessant pedestrian fatalities on the highway. This underscores the need for the erection of footbridges at appropraite locations, especially at traffic generating sites, such as schools, market centres, and hopitals to enhance their accessibility and encourage their use. This should be complemented with pedestrian information and education campaigns, on the safe use of the N1-Highway and other roads in Ghana, to preserve the lives of these vulnerable road users, while considering the enactment of legislation to regulate the behaviour of pedestrians in traffic.
Red traffic lights were hugely breached during the seven-day observation period. In all, 116 motorists were observed jumping red traffic lights. In effect, approximately 17 vehicles run the red traffic lights during the day on the highway. This endangers not only the safety of the driver and passengers of the errant motor vehicle, but also other road users who have the right of way (ROW) at that time, especially pedestrians who employ the traffic lights in accessing the highway.
Two-thirds of the pedestrians observed crossed the highway employing the traffic lights. In light of the inordinate traffic speeds and prevalence of motorists' traffic light violations, it is imperative that, pedestrians exercise extreme caution while using the pedestrian crossing. With excessive traffic speeds, a driver's breaking distance needed to stop safely increases, and does the danger of pedestrians misjudging closing traffic speeds needed to cross the highway safely. In view of this, pedestrians should yield to motorists and particularly ensure that, vehicles are completely stopped at the stop line at the traffic lights, even if they have the ROW, before stepping on the roadway. Considerations should also be given to the provision of grade-separated facilities, such as highly secured disability-friendly pedestrian subways, at appropriate locations along highways to segregate pedestrian movement entirely from motorized traffic, to obviate vehicle-pedestrian crashes, given that pedestrians are integral part of the road traffic mix in Ghana.

It is evident from the foregoing that, much remains to be done as regards the safe use of roads in Ghana. Road user education and training must be pursued and sustained, alongside strict enforcement of traffic safety regulations to modify road user behavior for safer travels.

4. Conclusions

Combined risk factors of excessive traffic speeds, running of red traffic lights, and poor road use by pedestrians among others contribute markedly to upsurge in road traffic fatalities on the N1-Highway, in Accra. Road user behavior thus, presents a significant road safety challenge on the N1-Highway.

5. Recommendations

i. High-speed cameras should be installed along the highway to ensure compliance with speed limits.
ii. Considerations should be given to the provision of highly secured disability-friendly pedestrian subways, to segregate pedestrian movements entirely from motorized traffic.
iii. Road user education and training must be pursued and sustained, alongside strict enforcement of traffic safety regulations to modify road user behavior for safer travels.
iv. Legislation to regulate the behavior of pedestrians in traffic should be considered.

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