AFRICAN JOURNAL OF APPLIED RESEARCH (AJAR)
www.ajaronline.com Vol.3, No.3 (Pages 69-81) ISSN 2408-7920 (March 2016)

EFFECT OF SPEED RAMPS ON FIRE TENDER AND SERVICE DELIVERY: A CASE STUDY OF THE CENTRAL REGION, GHANA

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ABSTRACT
Notwithstanding the claim that speed ramps and other speed calming devices reduce accidents on the roads, they have varied effects on occupants, the vehicle itself and ultimately reduce productivity through precious time lost. Speed ramps are a potential threat to the prompt service delivery of Ghana National Fire Service and possibly cause cumulative damage to fire tankers. Road traffic and safety policies have been solely centered on reduction of casualties on roads to the neglect of capital assets protection. Each year the country looses huge sums of capital resource owing to destruction of properties and the Ghana National Fire Service has been mostly blamed for their incapability to arrest some of these fire happenings. To address these issues, the research design ultilises a survey instrument devised to solicit fire tender drivers' perceptions about the consequence of speed ramps on the fire tankers and the service delivery of the institution. Data were collected from all the 14 operational fire stations present in the central region as well as service delivery responses vis-à-vis the speed ramp interactions from all the three well resourced fire stations in the metropolis. Interestingly, the analysed data revealed how speed ramps have contributed to some prominent repairable and non-repairable damages to the fire engines. There is also a relation between the number of speed ramps on access routes and the delivery response times of fire service crews at the fire scenes. The lessons learned and contributions to future road transport research are discussed herein.

Keywords: crack, water tank, banging, response time, tender driver.

1.0 INTRODUCTION

Most policy documents designed and implemented by governments on built environment have not been imbued with aspects that tend to protect both human and capital resources. As more essential services and production continue to remain centralized, one cannot guarantee the security of goods and infrastructure when speed calming interventions create huge restrictions to the emergency service delivery by fire service crews. The bad nature of road networks, poor road maintenance practices, uncontrolled human and vehicular traffics in addition to several unstandardised speed calming interventions on road have rendered the Ghana National Fire Service inefficient in service delivery and led to the loss of huge sums of capital resources each year (Appiah et al, 2010; Forkuo & Quaye-Ballard, 2013).

Irrespective of fire protection measures put forward by fire regulatory authorities, the dynamics of fire outbreak and control would continue to require a swift response by fire rescue teams (Harmathy, 1985; Don, 2003; Almirall & Furton, 2004; Drysdale, 2011). Most of these fire happenings do occur in the market places, fuel filling stations, institutional buildings and other populated places where traffic is a serious hurdle for the fire tender driver and the crew (Fleming, 2009). The current pervasiveness of unstandardised speed ramps together with the existing road irregularities have worsened the plight of fire rescue teams as the fire engine has to almost come to a stop before it maneuvers over the ramps without undue damage. It has been reported that firefighters are exposed to a number of physiological and psychological health risks (Brennan, 2011; Guidotti, 2016) and sometimes fire tenders suddenly run into speed ramps-causing serious injuries and possible deaths of occupants especially the tender driver. Occasionally, accidents of this nature do occur if due diligence on the part of the driver is not ensured.

Service delivery and productivity dynamics vis-à-vis the built environment have become one of the debatable issues that need re-orientation in most government agencies in developing countries worldwide. The mind teaser now is whether the circle can be squared. Ultimately, the department could not be blamed for poor service delivery without a proper retrospective assessment of the built environment within its operational boundaries. Apart from the possible delays that might be caused by speed ramps (Nuttall, 1999), the likelihood of health implications on the fire tender driver and crews needs to be investigated (Taylor, 2000; Lawson, 2003). In addition, the unstandardised speed ramps on roads make it difficult for tender drivers to spot ramps in advance, change tender speed and smoothly maneuver over ramps. This could be substantiated by the fact that typical Ghanaian roads are characterized by unpainted, unsigned and unevenly spaced speed ramps and speed limit-free ramps with positively skewed dimensions as against that of some other jurisdictions (Emslie, 1997; Reid, 1999; Walter, 1995).

It is imperative to have a retrospective assessment of the speed ramp interventions introduced within the built environment and its influence on fire service delivery, the fire tender driver and the fire tender itself. The goal was to measure the pervasiveness of ramps on access routes and to determine the extent of delays in emergency service delivery caused by speed ramps as well as assess whether or not speed ramps have had significant damage on the fire engine.

2.0 MATERIALS AND METHOD

Research Design

Accessibility to emergency scenes has become a major hindrance to prompt service delivery to victims and other affected persons. In order to understand some unclear issues that confront the Ghana National Fire Service, the intent of this study have been to assess the speed ramps on typical Ghanaian roads and the associated effect on fire tenders as well as possible delays in the crew's emergency service delivery. The goals of the research include the examination of the availability of speed ramps on roads vis-à-vis the major maintenance performed on the fire tenders, determination of the extent to which speed ramps could cause the tender water tank to crack and render it unfit for movement and more so to evaluate the extent of delays caused by the various types of ramps and their pervasiveness on roads. The conceptual framework *(Figure 1)* of the survey is centered on tender drivers' maneuvering skills versus road conditions, tender fault development and maintenance versus safety of drivers and crew and travel time delays in service delivery. The analysis of maintenance history, road irregularities, tenders drivers' maneuvering competence and experience can lead to a more comprehensive deduction of the cause of crack manifestation and other faults in fire service tenders as well as delay in emergency service delivery. For this study, questionnaires, observation checklists and secondary data on the response time per kilometer coverage of emergency cases, as well as ramp pervasiveness on access routes were used in fire stations in the central region.

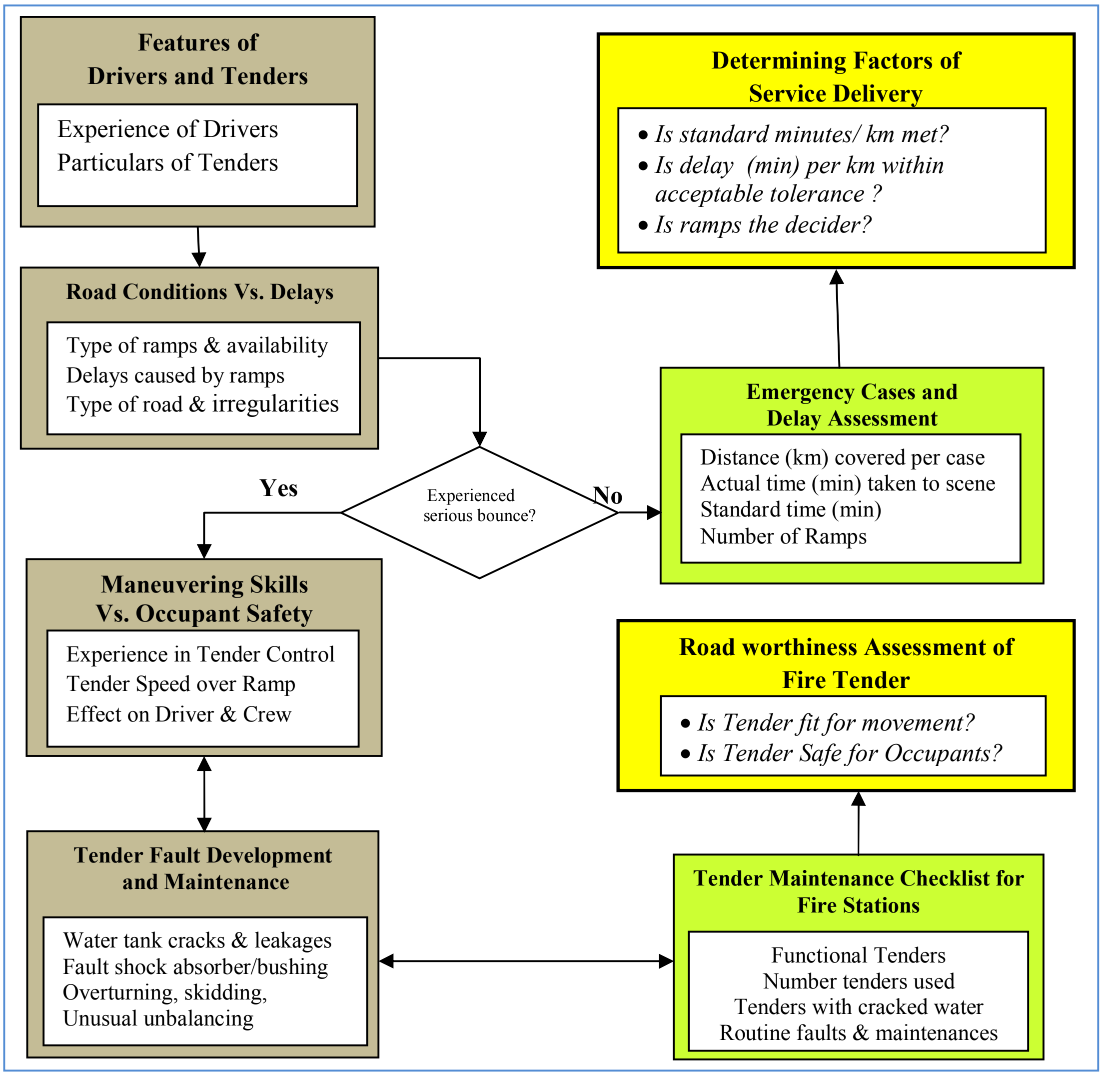

Figure 1: Conceptual framework on effect of ramps on fire tenders and service delivery.

Survey Design

Random sampling is used to sample the fire tender drivers in all the 14 operational fire stations present in central region and at least two tender drivers were captured for the study. Total sample size of 28 tender drivers was selected in the fire stations. The survey aimed to explore tender drivers' emergency trips, their health hazards and wheel-to-ramp banging interactions encountered using a comprehensive questionnaire. Most questions boarded on recalled attitudes and driver maneuvering skills as well as past traumatic experience of attending to emergency cases along access routes that are bumpy in nature. The survey was a short but in-depth interview of tender drivers using concise questionnaire of three printed pages that required less than 20 minutes to be administered. Respondents were interviewed in their choice of language to motivate respondents and reduce respondents' burden. Most exploratory questions had multiple choice items and respondent had the opportunity to either select one or more answers depending on the question. Descriptive statistic was used to analyse the data involving tables and graphs.

Observations on Fire Tender Maintenance

Maintenance checklist was used to solicit details of routine maintenance that are performed on individual fire tenders in all the three well resourced fire stations within the metropolis. The stations include Regional Head Quarters, Metropolitan and University of Cape Coast Fire Stations. There was a one-paged items checklist that captures information on the availability of tender, number of major maintenance per year, water tank leakage and road worthiness of the fire tender as well as the age of fire tenders. Data obtained were analysed to give results that might complement that of the tender drivers' survey results on the state of fire tenders in the region under the influence of speed ramps.

Data on Emergency Cases and Response Times

Data were also collated from all the three well resourced metropolitan fire stations in Central region of Ghana to capture information on the emergency cases that the stations have attended during the last two quarters, from 1st October, 2014 to 30th March, 2015 in order to assess the possible delays that might have been caused as a result of the presence of speed ramps on access routes of fire scenes. These stations include Head Quarters, Metropolitan and University of Cape Coast Fire Stations. In all 30 emergencies cases including twenty six (26) fire cases and four (4) accident cases were collated from the quarterly reports of the three fire stations. The data collated included the location of fire or accident scene, distance from fire station to the scene and time taken to approach the scene against the standard time required to approach the scene. The number of speed ramps on the access routes of all 30 recorded emergency cases was also obtained using tally sheets. The data were analysed in SPSS software and comparisons were made.

3.0 RESULTS AND DISCUSSION

Tender Driver and Road Condition

The rate of onset of impact acceleration determines the vibrational effect on occupants of vehicle and the tender itself. Tender drivers were probed to give an account of the ramp types and how they maneouver on these ramps encountered along access routes of emergency cases. Among the 14 fire stations visited, drivers asserted that the common ramps present were rumble strips (60.7%), followed by locally erected ramps (21.4%) with heap of soil, wood, or shallow dug trench and trapezoidal type (17.9%). Other uncommon ramps include circular profile ramps, plastic cushions and jiggle bars. Table 1 gives a meticulous account of the speed ranges at which drivers usually drive the fire engines over various ramps. It is observed that all drivers would normally have their fire engines almost come to a halt at speed range of 1-20 mph for a smooth maneuver over trapezoidal and circular ramps. More so, 89.3% of tender drivers tend to maneuver over locally erected ramps at 1-20mph. Perhaps because of the unfavourable ramp height drivers would have to safeguard their health and the possible damages to the fire engine. This would certainly contribute to a major source of delay in service response time.

Table 1: Estimated speed range observed by tender drivers over different ramps

Variable	Years in service					
	1-5	6-10	11-15	16-20	21 & above	Total
Rumble Strips						
1-20mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
21-40mph	0.0%	0.0%	42.9%	0.0%	0.0%	10.7%
41-60mph	80.0%	77.8%	42.9%	0.0%	100.0%	71.4%
61-80mph	10.0%	11.1%	0.0%	0.0%	0.0%	7.1%
81mph & above	10.0%	11.1%	14.3%	0.0%	0.0%	10.7%
Trapezoidal Speed Ramps						
1-20mph	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%
21-40mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
41-60mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
61-80mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
81mph & above	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Circular Profile Speed Ramps						
1-20mph	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%
21-40mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
41-60mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
61-80mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
81mph & above	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Plastic Cushion Ramp						
1-20mph	0.0%	11.1%	42.9%	0.0%	0.0%	14.3%
21-40mph	80.0%	88.9%	57.1%	0.0%	100.0%	78.6%
41-60mph	20.0%	0.0%	0.0%	0.0%	0.0%	7.1%
61-80mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
81mph & above	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Jiggle Bars						
1-20mph	10.0%	11.1%	14.3%	0.0%	0.0%	10.7%
21-40mph	50.0%	22.2%	57.1%	0.0%	0.0%	39.3%
41-60mph	40.0%	55.6%	28.6%	0.0%	100.0%	46.4%
61-80mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
81mph & above	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Locally Erected Ramp						
1-20mph	80.0%	88.9%	100.0%	0.0%	100.0%	89.3%
21-40mph	20.0%	11.1%	0.0%	0.0%	0.0%	10.7%
41-60mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
61-80mph	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
81mph & above	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Moreover, most drivers (78.6%) especially the most experienced (100%) would climb a cushion ramp at a speed range of 21-40mph. When movement over ramble strips were considered, it is found that 71.4% of drivers would bounce over rumble strips at a speed of 41-60mph without paying heed to the possible consequences on their health. Interestingly, 100% of the most experienced and probably the most aged and 80% of the most inexperienced could all maneuver over rumble strips at that speed ranges (41-60mph). Some tender drivers (10.7%) could maneuver at a very swift speed (81mph and above) and the cumulative vibrations and noise could be very detrimental to their health. Probably, they undergo all kinds of maneuvering at such a huge health risk - just to sacrifice their lives for others *(Guidotti, 2016).* Similar trend of maneuvering were also observed for movement over jiggle bars as shown in Table 1.

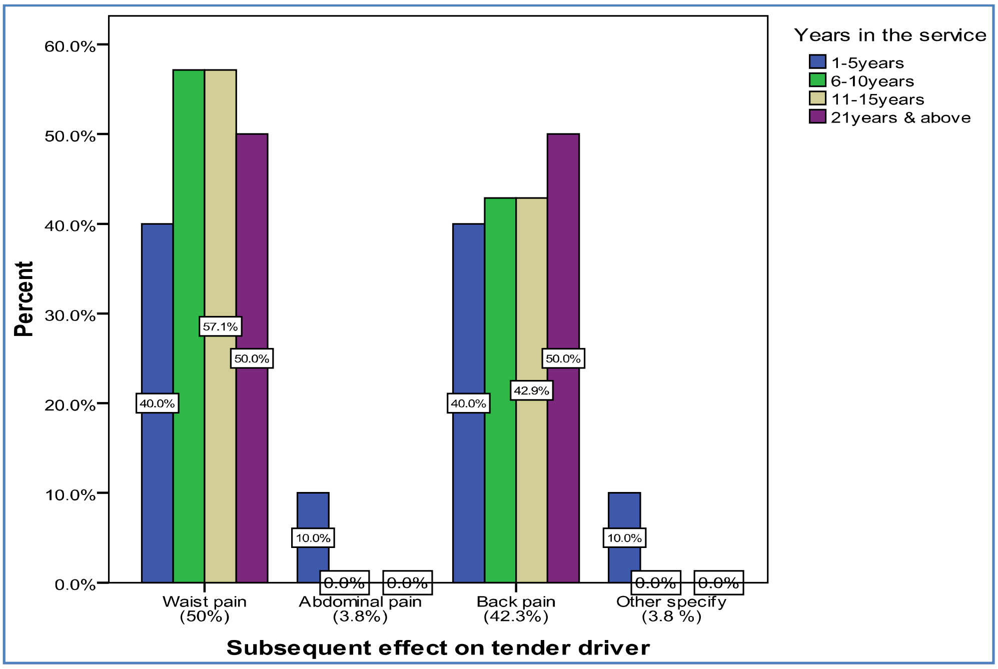

Figure 1: Effect of wheel-to-ramp banging on tender driver per service experience

Fire fighters have become secret victims to tragedy *(Regehr & Bober, 2005)* at both the tragedy scene - through exposure to mutilated bodies, mass damage and life-threatening conditions - and on the roads leading to the tragedy scene. During maneuvering on roads to fire and/or accident scenes, most drivers (81.7%) admitted that they have ever witnessed a serious bouncing over ramps. All the most experienced drivers and sizeable percentages of other experienced groups also made this disclosure. Concurrently, they complained of waist pain (50%), back pain (42.3%), abdominal pain (3.8%) and other health effects (3.8%) like headache and short dizziness.

Road Worthiness Assessment of Fire Tender

When tender drivers were asked to give account of how speed ramps might render a tender unfit for movement based on their recalled experiences, 42.9% of drivers confirmed that they have witnessed a water tank leakage in their previous or current station before. At the same time, more drivers (57.1%) claim they have not experienced such a leakage in their past or present station. However, the most experienced drivers (100%) who claim they have not experienced such a leakage could now perceive that ramps and other road irregularities like pot holes could cause the water tank to crack probably because workers would want to secure their jobs and as such might be reluctant and skeptical in pouring out some confidential information.

Apart from the fact that most drivers (92.9%) admitted that ramps could cause water tank of fire tender to crack, it is more evident in the responses obtained in Figure 2 as more specific damages caused to tender parts due to wheel-to-ramp banging were captured. Most of the damage are seen in the shock absorbers (38.5%) and followed by spoilt bushings (30.8%). Tyre deflation and/or burst accounted for 26.9% of damage whilst tender water tank cracks accounted for only 3.8% as reported by drivers in Figure 2.

The personal observations made at three stations revealed that at least one fire tender had had its water tank cracked in each of the stations. In Appendix C, out of a total of ten fire tenders used, three of them have been rendered unfit for movement due to substantial crack manifestations and water leakage. Perhaps these cracks might have accumulated over the years to render these tenders road worthless.

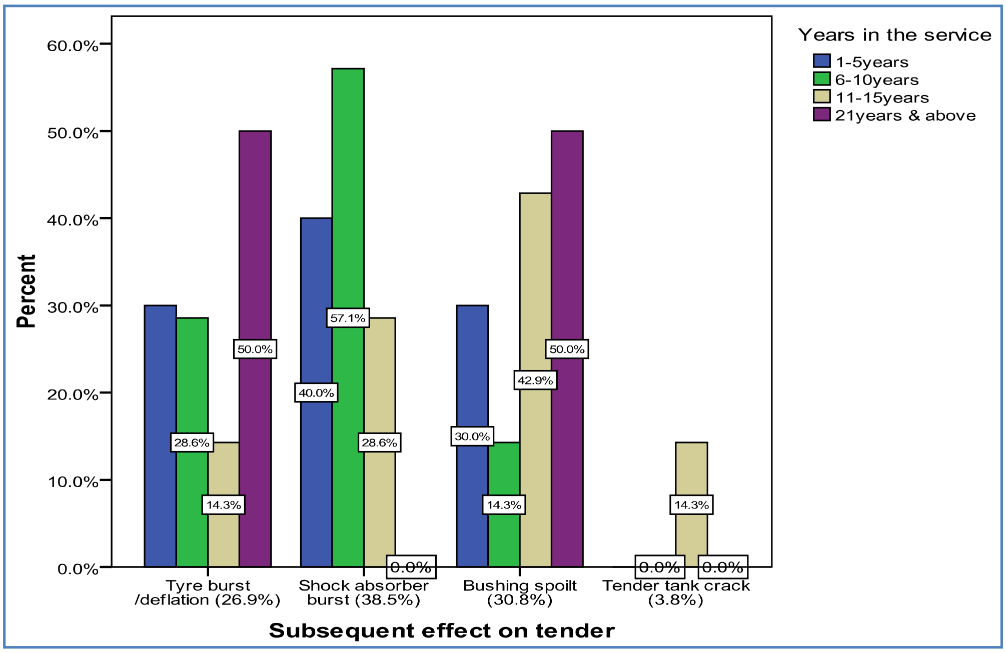

Figure 2: Effect of wheel-to-ramp banging on fire tender per driver service experience

The Determining Factors of Service Delivery: Ramps versus Delays

Fire tender drivers' introspective account on factors affecting the service delivery of Ghana National Fire Service has yielded interesting results. More drivers (75.0%) believe that speed ramps delay their work as much as one equivalent standard travel time. 20.8% of drivers asserted that it cost them twice and 4.2% of them feel that ramps could triple the commuting time of fire crew. The details of four different driver groups per experience are depicted in Figure 3. When the delays in fire crew movements in central region were further examined and compared using a re-organized data from all the three well resourced stations within the Cape Coast metropolis some coincidence and few disagreements were discovered. From Appendix B1, it is observed that at all times the actual times (minutes) were equal or greater than the recommended standard times (minutes) except in two cases where the fire crews arrived at an earlier time than expected. In the case of non-metropolitan areas of the region *(Neville et al, 1989)* - where the fire stations are not fully resourced – the issue of responders' delay would surely exacerbate the problem of poor incident management by the Ghana National Fire Service.

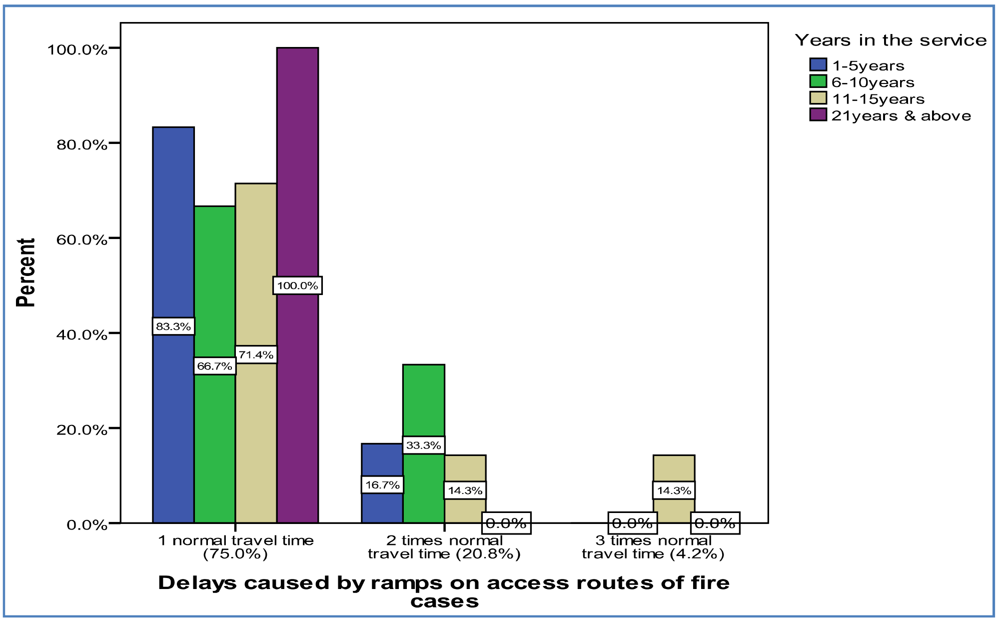

Figure 3: Delays caused by ramps as assessed tender drivers per service experience

Delays could not be fully attributed to the number of ramps and kilometer coverage as substantial delays were also recorded in cases with no ramps on access routes for all the three stations. Perhaps this may be due to lack of timely interventions and effective incident management systems *(Fleming, 2009)* by Ghana National Fire Service and partly attributed to traffic and congestion in some parts of communities close to the fire scenes. More so, Figure 4 concretises the fact that delays could not be solely blamed on the number of ramps erected on access routes as there were two clear cut cases where the fire team arrived earlier than expected though there was a substantial number of ramps on access routes.

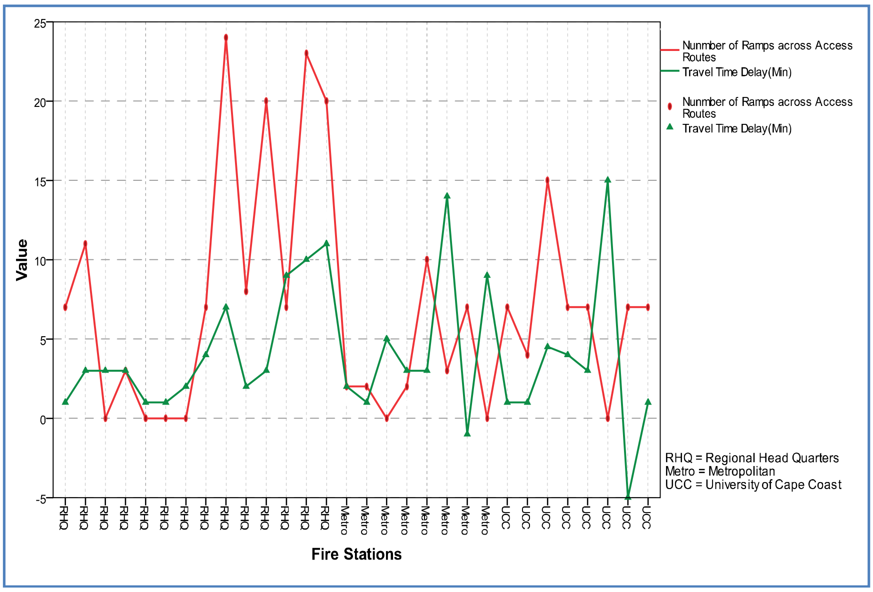

Figure 4: Number of ramps on access routes for case against travel time delay.
(Data partly collated from GNFS Quarterly Reports between 10/ 2014 to 03/2015)

However, when the Pearson's correlation (Appendix B2) was used to compare the relation between the two variables, number of ramps on routes and travel time delays, a weak positive correlation of 0.187 is found between them.

4.0 CONCLUSION AND RECOMMENDATION

Regardless of the speed ramp specifications used for the construction, their presence on the roads would continue to create appreciable impediments to the movement of fire crews to attend to emergency cases. The presence of speed ramps on roads would remain positively correlated to travel time delay of fire crews and consequently affect the overall service delivery of Ghana National Fire Service. Speed ramps affect both the occupants and the tender in diverse ways. It causes a lot of waist pain and back ache to fire crews and damage the suspension, control components and water tanks of the fire engine. Re-orientation and redesigning of ramps to create central maneouvering way on highways and other roads for emergency vehicles would be the ultimate solution to rapid emergency response.

On the contrary, speed ramps on roads could not be the only determining factor that might affect service delivery of the Ghana National Fire Service. It is also recommended that future research should be tailored towards other possible factors such as traffic, congestion and crew's preparedness towards take-off from the fire station. Moreover, detailed analysis into various defects caused by speed ramps is required to, for instance, help pinpoint the extent of ramp-induced cracks in tanks and their manifestation mechanism in the water tank of fire tenders.

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APPENDIX A

DRIVERS' EXPERIENCE AND FIRE STATIONS CAPTURED

Years in the service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5years	10	35.7	35.7	35.7
	6-10years	9	32.1	32.1	67.9
	11-15years	7	25.0	25.0	92.9
	21years & above	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

Fire Stations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Head Quarters	2	7.1	7.1	7.1
	Metro	2	7.1	7.1	14.3
	UCC	2	7.1	7.1	21.4
	Elimina	2	7.1	7.1	28.6
	Assin Fosu	2	7.1	7.1	35.7
	Apam	2	7.1	7.1	42.9
	Twifo Praso	2	7.1	7.1	50.0
	Budumburam	2	7.1	7.1	57.1
	Mankessium	2	7.1	7.1	64.3
	Swedru	2	7.1	7.1	71.4
	Winneaba Junction	2	7.1	7.1	78.6
	Bremang Essiam	2	7.1	7.1	85.7
	Bremang Essikuma	2	7.1	7.1	92.9
	Komenda	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

APPENDIX B1

EMERGENCY CASES, SERVICE RESPONSES AND NUMBER OF RAMPS ACROSS ACCESS ROUTES

S/N.	STATION CODE	FIRE STATION [1]	DETAILS OF CASE	DISATNCE COVERED / (km)	STANDARD TIME / (Minutes)	ACTUAL TIME / (Minutes)	TRAVEL TIME DELAY / (Minutes)	NUMBER OF RAMPS
1	1	RHQ	Fire at SDA Church, Cape Coast	1.0	1.0	2.0	1.0	7
2	1	RHQ	Fire at The National School	2.0	1.0	4.0	3.0	11
3	1	RHQ	Fire at kakumdo	1.5	1.0	4.0	3.0	0
4	1	RHQ	Fire at Industrial Area	2.0	1.0	4.0	3.0	3
5	1	RHQ	Fire at Eyifua Estate	2.0	1.0	2.0	1.0	0
6	1	RHQ	Accident at Pedu Junction	1.0	1.0	2.0	1.0	0
7	1	RHQ	Fire at Seminary Near Pedu Junction	1.0	1.0	3.0	2.0	0

8	1	RHQ	Fire at Siwdo (Cape Coast)	2.0	1.0	5.0	4.0	7
9	1	RHQ	Fire at Yamoransa	3.0	2.0	9.0	7.0	24
10	1	RHQ	Accident at Bakano Hospital	3.0	2.0	4.0	2.0	8
11	1	RHQ	Fire at Waakrom Near Yamoransa	4.0	2.0	5.0	3.0	20
12	1	RHQ	Fire at Amissano	8.2	4.0	13.0	9.0	7
13	1	RHQ	Accident at Biriwa	8.0	4.0	14.0	10.0	23
14	1	RHQ	Accident at Komenda	13.0	10.0	21.0	11.0	20
15	2	Metro	Fire at Bakaano (Cape Coast)	1.0	1.0	3.0	2.0	2
16	2	Metro	Fire at Ola	1.5	1.0	2.0	1.0	2
17	2	Metro	Fire at holy child	2.0	1.0	6.0	5.0	0
18	2	Metro	Fire at Ntotoonu (Cape Coast)	1.0	1.0	4.0	3.0	2
19	2	Metro	Fire at Anteamu	3.0	2.0	5.0	3.0	10
20	2	Metro	Fire at Nkanfoa	3.0	2.0	16.0	14.0	3
21	2	Metro	Fire at Siwdo	3.0	2.0	1.0	-1.0	7
22	2	Metro	Fire at Green Hill	6.0	3.0	12.0	9.0	0
23	3	UCC	Fire at Duakor Near Ucc	1.0	1.0	2.0	1.0	7
24	3	UCC	Fire at Ucc Account Office	1.0	1.0	2.0	1.0	4
25	3	UCC	Fire at Industrial Area	2.0	1.5	6.0	4.5	15
26	3	UCC	Fire at Broyibima	3.0	2.0	6.0	4.0	7
27	3	UCC	Fire at Elmina	3.0	2.0	5.0	3.0	7
28	3	UCC	Fire at Ankanful Near Elimina	8.0	6.0	21.0	15.0	0
29	3	UCC	Fire at Yesu Nkwa(Ataabadze)	9.8	13.0	8.0	-5.0	7
30	3	UCC	Fire at Aseaman near Ataabadze	10.0	14.0	15.0	1.0	7

[1]RHQ = Regional Head Quarters Fire Station, UCC= University of Cape Coat Fire Station and Metro = Metropolitan Fire Station

(Author's field work: Part of data collated from GNFS Quarterly Reports submitted for two quarters between 10/ 2014 to 03/2015)

APPENDIX B2

CORRELATION BETWEEN NUMBER OF SPEED RAMPS ACROSS ACCESS ROUTES AND TRAVEL TIME DELAY

		Number of Ramps across Access Routes	Travel Time Delay
Number of Ramps across Access Routes	Pearson Correlation	1	0.187
	Sig. (2-tailed)		0.321
	N	30	30
Travel Time Delay	Pearson Correlation	0.187	1
	Sig. (2-tailed)	0.321	
	N	30	30

APPENDIX C

PARTICULARS OF TENDERS IN THREE FIRE STATIONS

Variable		Name of Fire Station			
		RHQ	**Metro**	**UCC**	**Total**
Tenders with cracked Tanks seen on premises		1	1	1	3
Number of Functional Tenders		3	1	1	5
Number of Tenders Used up to Date		4	4	2	10
Year of Importation of Functional Tenders					
	Tender 1	2013	2014	2013	
	Tender 2	2009			
	Tender 3	2009			
Year of Manufacture of functional Tenders					
	Tender 1	2013	2014	2013	
	Tender 2	2000			
	Tender 3	2000			