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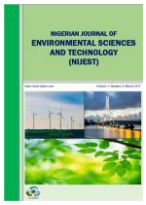

Investigation of Speed Bumps on Urban Centre Road in Ugbowo Benin-City, Edo State

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ABSTRACT

This study investigated the use of speed bumps on Nigeria highway with specific reference to the section of the federal road that start from the University of Benin main gate to Oluku Junction Benin city. Using survey methodology for the collection of information from a sample of individuals through their responses to questions like who, how much, what, where, when, how many, and how, 50 units of questionnaires each were designed and administered to drivers, motorist and residents at various reference points on the road section to sought information on the effect of the devices on the drivers, motorist and residents. Measurement of the height, width, length and spacing of the device was also carried out with a Measuring tape and digital distance measuring wheel. The result shows that speed bumps in the study area have been effective in speed and accident reduction. However, the devices were not built to specification as the height, width, length and spacing were at variance. In order to promote safety, it was thus advised that speed bumps be taken into consideration on roadways where concentrated generators of pedestrian activity are present for possible prevention of any unlawful placement of the device.

Keywords: Road Safety, Calming, Traffic Management, Speed bumps and Geometry

1.0. Introduction

Speed bumps (also called road bumps) are raised pavement spanning completely or partly across a roadway using a vertical deflection method of traffic calming to force drivers to reduce the speed of their vehicles in order to minimize uncomfortable bumping or vibrating sensation produced when traversing them (Park Hill et al., 2007). The employment of these vertical deflection devices is prevalent around the world, and they are most frequently observed at locations where low vehicle speeds are legally required, typically between 8 and 16 km/h (5.0 to 9.9 mph) or 40 km/h (25 mph) (Watts, 1953). The heights ranges from 76 and 102millimeters (3and 4 inches) and traverse distance typically 0.30 to 1m (1 ft) (ITE, 2017). Previous research from several countries suggests that to achieve overall speeds of 25 to 30 km/h on road, speed bumps should be placed between 40 and 60 meters apart, and up to 100 meters, for speeds of 50 km/h on road.

According to the Illustrated Glossary for Transport Statistics (2019), a road is defined as a line of communication (travelled way) open to public traffic, primarily for the use of road motor vehicles, with a stabilized base. However, as they are built, they bypass large, small, and dispersed settlements that use the road's locational impetus for their own development and re-organization and further integrate themselves into larger communities spread along the road. In each community, in a bid for members to link their peers and friends on other side of the roads, those that are not vigilant enough are seriously injured or killed by reckless motorists. A report published by the World Health Organization (WHO) in 2004 estimated that some 1.2 million people were killed and 50 million injured in traffic collisions on the roads around the world each year and was the leading cause of death among children 10-19 years of age. The report also noted that the problem was most severe in developing countries and that simple prevention measures could halve the number of deaths. In 2001, Afukaar (2001) studied the methods used in developing countries to regulate speed. Ghana was used as a case study to examine the issues, challenges, and potential for reducing traffic injuries as well as evaluations of previous studies on speed

control strategies. The results showed that pedestrians were mostly injured in road traffic accidents, and that between 1958 and 2000, speed alone was accountable for more than half of all traffic events in Ghana. Rumble strips and speed bumps were discovered to be efficient alternatives to traffic police enforcement of speed limits, which may be beyond the means of most developing countries. The efficiency of traffic calming methods on urban streets with mixed traffic circumstances was also studied by Raghupathi and Vedagiri (2021).

The selected traffic calming techniques were compared to the identified speed profiles of heavy and light commercial vehicles, cars, three-wheelers, and motorbikes. A crossing speed between 6 and 14 kmph was observed to be significantly reduced by the speed bump. Further research into the effects of speed variations on road bumps was conducted by Beckman and Kuch in 2000. Their work is guided by the following research questions: (1) Could bump be the speed-limiting factor? (2) In an aerodynamic car, could a bump cause a sudden, catastrophic loss of downforce and adhesion? To analyse these issues, the researchers looked into the connection between bump violence and speed. Kosakowska (2022) and Kiran et al (2020) took further a holistic approach to critically analyze speed bumps on various account and its impact on the safety of the road users.

Nigeria, a developed nation with many highways and a growing population, is not exempt from traffic accidents caused by negligent drivers. In 2015, students from the University of Benin stormed the road, blocked it, and demanded that bumps be immediately installed before they could leave in protest at the deaths of several of their members (Daily Trust, 2015). The Federal Road Safety Corps also reported 5,320 accidents, 2,471 fatalities, and 15,882 injuries nationwide between January and June 2021 (Vanguard, 2021). The first three quarters of the same year offer a chance for discussion and conversation across the nation on the role of speed bumps in road safety because of the alarming nature of these data. Chukwugozi (2014) used a case study on the Akure-Ado, Akure-Owo, and Ikare-Owo highways to assess the level of acceptance of installing speed bumps among road users in Ondo State. According to the paper, installing bumps has detrimental effects on drivers and passengers, including increased wear and tear on car mechanical systems, frequent tyre punctures, longer travel times, physical stress and pain, and widespread opposition to the installation.

Prior to the decision of either the removal or placement of speed bumps in any location, it is of immense important to investigate the used of these speed bumps in other similar location. On this basis, this research work seeks to investigate the use of speed bumps on urban centres road in Ugbowo, Benin-City in order to ascertain if its effect commensurate with its intended purpose, and if an unexpected problem were created. The result from this research work will prove evident if the current practice of installing speed bumps in densely populated urban centres should be supported or abandoned. Consideration can subsequently be given to mitigation measures, such as potential removal, if the installation of speed bumps led to unfavourable safety or traffic operations difficulties.

2.0. Methodology

2.1. Study Area

The study area is the section of the federal road that start from the frontage of University of Benin (UNIBEN) main gate and proceeds to Oluku in Edo state. This road section being from UNIBEN main gate and pass through Evidence Church, and further extends to 7-up bottling warehouse, before it finally terminated at Eresonyen Primary school close to Oluku road junction. This place is situated in OviaNorth, Edo state, Nigeria, with its geographical coordinates 60 30’16.92” North and 50 36’ 13.32” East.

2.2. Methods

This work was carried out through basic research as opposed to applied research. This research follows thus in 3 phases according to John W. Creswell: pose a question, collect data to answer the question, and present an answer to the question. In this work, the quantitative research method was used, which according to Lisa (2008) is the systematic empirical investigation of observable phenomena via statistical, mathematical or computational techniques. Whose objective according to Apuke (2017) involves the utilization and analysis of numerical data using specific statistical techniques to answer questions like who, how much, what, where, when, how many, and how. The major research type used

under the quantitative research method was the survey methodology which according to Check and Schutt (2011) involves the collection of information from a sample of individuals through their responses to questions.

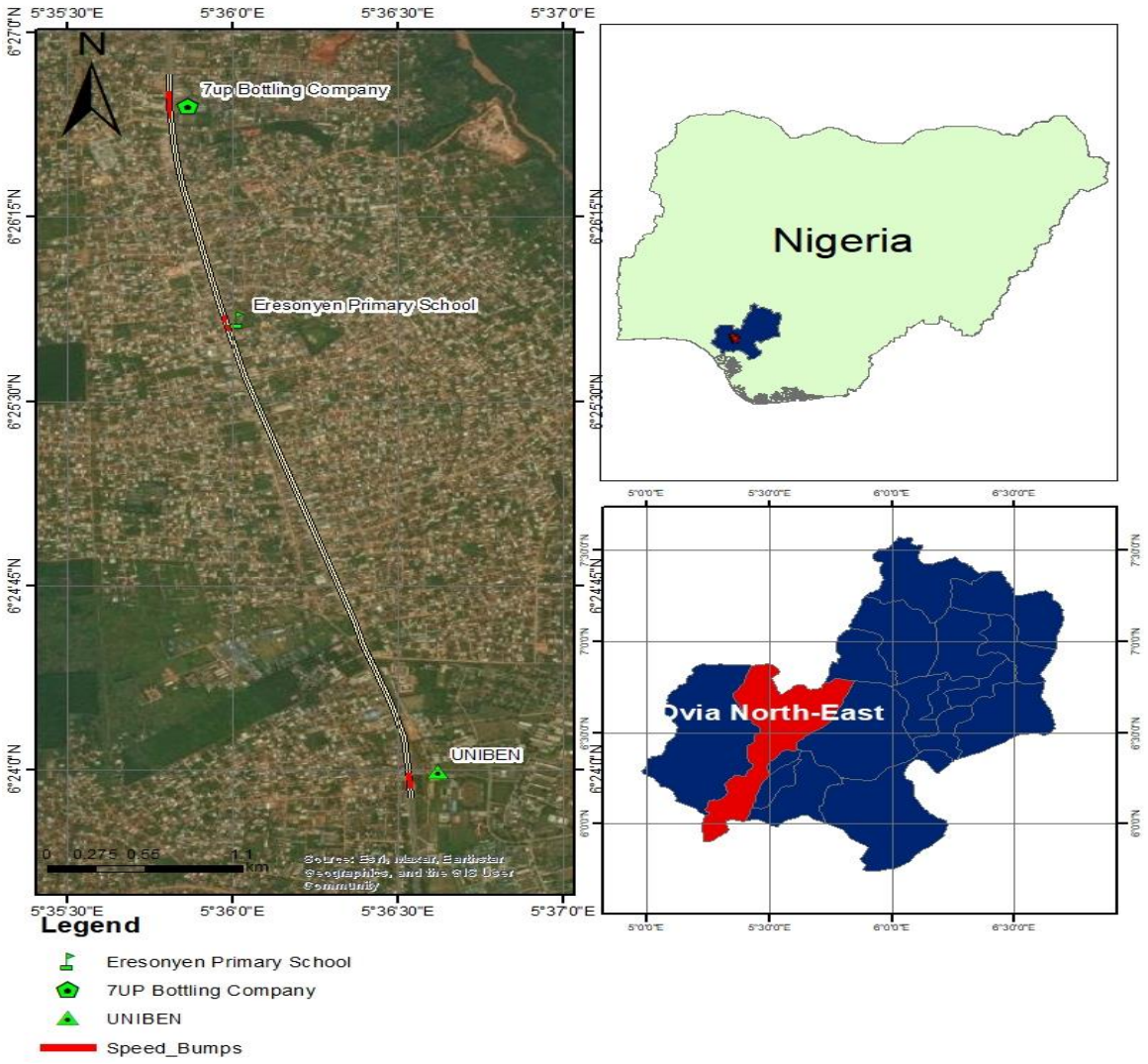

Figure 1: Map of study area

2.3. Data collection techniques

Two types of data that were collected for this research are: Primary and Secondary data. The primary data were collected from three locations on the section of the highway; University of Benin (UNIBEN)-Main gate, 7-UP bottling company warehouse and Eresonyen primary school. The primary sources of data were collected through the following means:

2.3.1. Direct observations

Personal and visual observation of the operation on the use of the speed bumps in the selected areas was carried out. This was done so as to check the activities going on in the respective location, the congestion of the area under study, the type of road bump used and materials used for the construction of such road bumps.

*2.3.2. Measurement using tape and digital distance measuring whee*l

Measurement of the length, height, width, and the spacing between one bump to another were undertaken using meter rule and digital distance measuring wheel in the study area. The width of the bumps was taken as the width of the road section. The height of the bumps was measured in a vertical direction from the road surface to the vertex of the bump. The length of the bumps was measured in a horizontal direction from one point of zero height of the bumps to the other point of zero height on the bumps other side. The spacing between the bumps were measured in-in of two respective bumps

2.3.3. Questionnaire

On May 21, 2017, drivers and experts in the chosen street had the chance to provide their opinions about the impact of the road bumps. The questionnaires were created to gather data on the effects of bumps on Edo State's highways in relation to the study region. The rates of accident incidence, road maintenance, user confidence, and speed of motorists before and after the installation of bumps were the areas evaluated in the questionnaires. Other factors include the efficiency of traffic enforcement officers, the use of speed bumps, a comparison of the various speed bumps in the research region, and the harm they have caused. In each of the three locations—the main entrance of the University of Benin, the warehouse of the 7-UP bottling company, and Eresonyen Primary School—50 questionnaires were given out to randomly chosen responders. Those who were positively impacted by the placement of the bumps received the questionnaire.

In an effort to strengthen the information obtained from primary sources and make it accurate, secondary data were gathered from journals, daily newspapers, textbooks, and the internet.

2.4. Data analysis technique

A statistical analysis was done on the data that was gathered for the study. In order to rank the attitudes in reaction to the examination of speed bumps in Ugbowo Benin-City, Nigeria, frequency counts and simple percentages were utilized. Themes were created from the measurement and observational data, which were then compared to the guidelines for traffic calming measures for analysis by the Institute of Transportation Engineer Traffic calming measures.

3.0. Results and Discussion

3.1. Road bumps geometry

Results obtained from the measurement of the height, length and width of speed bumps in the study are presented in the tables 1 to 4. Also, included in the tables are the physical observation of the material used for the bumps.

Table 1: Parameters of road bumps at University of Benin main gate

Bumps	Width, W (m)	Height H(m)	Material used
1	0.30	0.03125	Asphalt
2	0.20	0.03125	Asphalt
3	0.20	0.03125	Asphalt
4	0.25	0.03125	Asphalt
5	0.40	0.03125	Asphalt
6	0.20	0.03125	Asphalt
7	0.30	0.03125	Asphalt
8	0.40	0.06250	Asphalt
9	0.20	0.03750	Asphalt
10	0.30	0.06250	Asphalt
11	0.40	0.06250	Asphalt
12	0.20	0.03750	Asphalt
13	0.40	0.06250	Asphalt
14	0.30	0.06250	Asphalt
15	0.40	0.06250	Asphalt
16	0.40	0.03125	Concrete
17	0.35	0.06250	Asphalt
18	0.20	0.03750	Concrete
19	0.20	0.03750	Asphalt
20	0.35	0.06250	Asphalt
21	0.35	0.05000	Asphalt

Table 2: Parameters of road bumps at 7-UP

Bumps	width (m)	Height from the pavement (m)	Material used
1	0.30	0.0375	Asphalt
2	0.30	0.0375	Asphalt
3	0.30	0.0375	Asphalt
4	0.30	0.0750	Asphalt

5	0.50	0.0500	Asphalt
6	0.50	0.0500	Asphalt
7	0.50	0.0625	Asphalt
8	0.40	0.0625	Asphalt
9	0.25	0.0500	Asphalt
10	0.50	0.0625	Asphalt
11	0.45	0.0625	Asphalt
12	0.30	0.0625	Asphalt
13	0.30	0.0625	Asphalt
14	0.30	0.0700	Asphalt
15	0.65	0.0625	Asphalt
16	0.35	0.0375	Asphalt
17	0.60	0.0625	Asphalt

Table 3: Parameters of road bumps at Eresonyen Primary School

Bumps	width (m)	Height from the pavement (m)	Material used
1	0.30	0.050	Asphalt
2	0.25	0.050	Asphalt
3	0.30	0.050	Asphalt
4	0.70	0.075	Asphalt
5	0.35	0.050	Asphalt
6	0.25	0.050	Asphalt
7	0.25	0.050	Asphalt

Table 4: Spacing of the road bumps

University of Benin main gate		Eresonyen Primary School		7-UP Bottling Company	
Bumps	**Spacing (m)**	**Bumps**	**Spacing (m)**	**Bumps**	**Spacing (m)**
1-2	0.15	1-2	0.10	1-2	0.20
2-3	0.15	2-3	0.15	2-3	0.20
3-4	0.15	3-4	36.00	3-4	0.20
4-5	64.00	4-5	34.00	4-5	64.00
5-6	0.10	5-6	0.15	5-6	0.30
6-7	0.20	6-7	0.15	6-7	27.00
7-8	65.00	1-2	0.10	7-8	0.20
8-9	0.15			8-9	0.35
9-10	0.10			9-10	0.25
10-11	59.00			10-11	46.00
11-12	0.15			11-12	0.10
12-13	0.15			12-13	0.25
13-14	79.00			13-14	0.20
14-15	0.25			14-15	40.00
15-16	14.00			15-16	0.15
16-17	23.00			16-17	0.25
17-18	0.15				
18-19	0.20				
19-20	0.20				
20-21	42.00				

Table 5: Signage for the road bumps at University of Benin main gate, 7-UP and Eresonyen

Location	Signage type	Distance from bumps (m)	Height (m)	Width (m)	Text height (m)	Visibility
UNIBEN	vertical	36	2.3	0.6	0.07	Partially
7-UP	vertical	88	3.0	0.6	0.07	Not
Eresonyen	vertical	152	2.9	0.6	0.04	Partially

The specifications of the road bumps collected from all 3 locations were displayed in tables 1–5. The majority of the materials employed in its construction were found to be made of asphalt. Only 4.4 percent of the speed bumps that were examined were composed of concrete. It was recalled that those made of concrete were the ones forcefully erected by the student of the University of Benin Additionally, the geometry of the existing speed bumps was looked into. Ideal speed bump specifications include a height of 0.076 to 0.1 meters, a travel distance of 0.3 to 1 meter, spacing of 40

to 100 meters, and both containing horizontal and vertical signage. However, as shown in tables 1-3, 100% of the bumps had heights below the required level, with a little over a quarter (26.7%) falling between 0.2 m and 0.25 m has width below standard. Investigative work was also done on the bumps' signage.

Table 5 demonstrated that there was no thought given to horizontal signage and that solely vertical signage was used. This could be hazardous because most drivers frequently ignore sideways signs. Also, the vertical signage text height used for all 3 locations are shorter than required text height of 0.125metre. Additionally, the signage at 7-UP Bottling Company and Eresonyen were seen to be obstructed by trucks and posters respectively. The uneven geometry of the speed bumps along the road stretch suggests that no standard or policy was adhered to when designing and building them.

3.2. Administered questionnaires report

Table 6. Question One: Speed rating of vehicle before the erection of bumps

	Very High	**High**	**Low**	**Very Low**
UNIBEN	27	15	8	0
7-UP	29	13	7	0
Eresonyen	28	17	5	1
Total	**84**	**45**	**20**	**1**
Percentage	**56.00%**	**30.00%**	**13.33%**	**0.67%**

Table 7. Question Two: Speed rating of vehicle after the erection of bumps

	Very High	**High**	**Low**	**Very Low**
UNIBEN	2	6	35	7
7-UP	13	12	23	2
Eresonyen	0	5	39	6
Total	**15**	**23**	**97**	**15**
Percentage	**10.00%**	**15.33%**	**64.67%**	**10.00%**

Table 8. Question Three: Should speed on a highway be controlled?

Location	**Yes**	**No**
UNIBEN	47	3
7-UP	47	3
Eresonyen	44	6
Total	**138**	**12**
Percentage	**92.00%**	**8.00%**

Table 9. Question Four: Confidence in using the road before the erection of bumps

	Very High	**High**	**Low**	**Very Low**
UNIBEN	7	12	23	8
7-UP	5	5	29	11
Eresonyen	4	12	28	6
Total	**16**	**29**	**80**	**25**
Percentage	**10.67%**	**19.33%**	**53.33%**	**16.67%**

Table 10. Question Five: Confidence in using the road after the erection of bumps

	Very High	**High**	**Low**	**Very Low**
UNIBEN	14	24	12	0
7-UP	12	29	8	1
Eresonyen	3	37	9	1
Total	**29**	**90**	**29**	**2**
Percentage	**19.33%**	**60.00%**	**19.33%**	**1.33%**

According to respondents' assessments of table 6, the speed before the erection of bumps was as follows: 56% rated the evaluation as very high, 30% as high, 13.3% as low, and 0.7%t as very low. According to respondents' assessments of table 7, the speed after the installation of bumps was as follows: 10% gave it a very high rating, 15.3% a high rating, 64.7% a low rating, and 10% a very low rating. Tables 6 and 7 can be compared to show how the installation of bumps decreased highway traffic speed.

Table 11. Question Six: Occurrence of accident rating before the erection of bumps

	Very High	**High**	**Low**	**Very Low**
UNIBEN	23	16	10	1

7-UP	19	21	9	1
Eresonyen	11	32	7	0
Total	**53**	**69**	**26**	**2**
Percentage	**35.33%**	**46.00%**	**17.33%**	**1.33%**

Table 12. Question Seven: Occurrence of accident rating after the erection of bumps

	Very High	**High**	**Low**	**Very Low**
UNIBEN	4	6	30	10
7-UP	7	10	27	6
Eresonyen	2	5	39	4
Total	**13**	**21**	**96**	**20**
Percentage	**8.67%**	**14.00%**	**64.00%**	**13.33%**

Table 13. Question Eight: Was the road properly maintained before the erection of bumps?

	Well maintained	**fairly maintained**	**Not maintained**
UNIBEN	6	35	9
7-UP	6	25	19
Eresonyen	2	39	9
Total	**14**	**99**	**37**
Percentage	**9.33%**	**66.00%**	**24.67%**

Table 14. Question Nine: Was the road properly maintained after the erection of bumps?

	Well maintained	**Fairly maintained**	**Not maintained**
UNIBEN	3	39	8
7-UP	22	23	5
Eresonyen	8	26	16
Total	**33**	**88**	**29**
Percentage	**22.00%**	**58.67%**	**19.33%**

From table 11, 35.33% of respondents agreed that the occurrence of accident before building of bumps on highway in the study area was very high, 46% agreed that it was high, 17.33% agreed it was low and 1.33% agreed it was very low. From table 12, the respondents agreed that the occurrence of accidents after the erection of bumps on the highway of the study area was 64% (low) and 13.33% (very low). Tables 11 and 12 can be compared, and the difference shows that installing bumps reduces the number of accident victims on the road. From table 13, 66% of the respondents assessed that the road was fairly maintained, 24.67% assessed that the road was not-maintained and 9.33% assessed that the road was well-maintained. From table 14, the respondents assessed that 58.67%, 22% and 19.33% were fairly maintained, well maintained and not maintained respectively. The majority of respondents (66% and 58.67%, respectively) in tables 13 and 14 responded that the road was moderately maintained. This suggests that little changes occur in terms of maintenance from the time there were no bumps to the time the bumps were put in place. This can be detrimental to road users as attempt of motorists to maneuver through a damage speed bump might lead to collision.

Table 15. Question Ten: How effective has road signs been in regulating traffic flow

	Very effective	**Effective**	**Partially effective**	**Non-effective**
UNIBEN	2	10	31	7
7-UP	6	11	26	7
Eresonyen	8	7	28	7
Total	**16**	**28**	**85**	**21**
Percentage	**10.67%**	**18.67%**	**56.67%**	**14.00%**

Table 16. Question Eleven: How can you describe the speed bump in this location to the others you have encountered?

	Better	**Fair**	**Too high**
UNIBEN	14	33	3
7-UP	20	27	3
Eresonyen	21	26	3
Total	**55**	**86**	**9**
Percentage	**36.67%**	**57.33%**	**6.00%**

Table 17. Question Twelve: How would you rate the condition of most vehicle passing over the speed bump?

	Very good	Good	Fair	Bad
UNIBEN	1	24	24	1
7-UP	2	26	15	2
Eresonyen	1	31	20	3
Total	**4**	**81**	**59**	**6**
Percentage	**2.67%**	**54.00%**	**39.33%**	**4.00%**

Table 18. Question Thirteen: Has speed bump done more harm than good?

	Yes	No	Can't say
UNIBEN	3	42	5
7-UP	7	40	3
Eresonyen	6	41	3
Total	**16**	**123**	**11**
Percentage	**10.67%**	**82.00%**	**7.33%**

Table 19. Question Fourteen: How does the idea of speed bumps on an highway sound to you

	Good	Fair	Not good
UNIBEN	24	24	2
7-UP	30	14	6
Eresonyen	34	14	2
Total	**88**	**52**	**10**
Percentage	**58.67%**	**34.67%**	**6.67%**

Table 20. Question Fifteen: Would you have wanted the speed bump in this location to be remove

	Yes	No	I don't know
UNIBEN	3	44	3
7-UP	5	43	2
Eresonyen	4	44	2
Total	**12**	**131**	**7**
Percentage	**8.00%**	**87.33%**	**4.67%**

Table 21. Question Sixteen: If there are other route to your destination without passing this speed bumps, would you still follow this same route

	Yes	No	I don't know
UNIBEN	12	32	7
7-UP	29	16	5
Eresonyen	32	9	8
Total	**73**	**57**	**20**
Percentage	**48.67%**	**38.00%**	**13.33%**

Table 22. Question Seventeen: What do you love most about this speed bump?

Comment	Number of Response
Increases safety level	80
Speed were reduced	45
Poses consciousness to drivers	7
No response	18

Table 23. Question Eighteen: What do you hate most about this speed bump?

Comment	Number of Response
Damage to vehicle	30
Delay	26
Poor design	25
Numerous	10
Tampered road aesthetic	2
Noise	2
Improper usage by road users	12
No maintenance on bumps	2
No response	41

In table 15, the available road signs were rated by respondents as follows: 56.67%, 18.67%, 14% and 10.67% as being effective, partially effective, non-effective and highly effective respectively. Generally, tables 9, 10, 18, 20, 22 and 23 all showed the effect of speed bumps as indicated by the respondent. From table 18, 82% of the respondents indicated that speed bump had done better than harm to them. Respondents expressed why they loved the device and also why they hated the device.

4.0. Conclusions

This study assessed the use of speed bumps as a traffic-calming device in Ugbowo, Benin City, Nigeria, in order to increase the safety of the locals and the vulnerable in the region. Although the use of bumps had been researched and they had been shown to help reduce overspeeding and accidents, the construction was not done properly as evidenced by the uneven height, width, and spacing, which will negatively affect their effectiveness and efficiency as traffic calming measures there.
The following recommendations were made in order to lessen the effects that speed bumps have on the study area's people and cars while also improving the positive impacts:

i. The existing speed bumps with height, width and spacing more than the general acceptable standard that were found on the highway linking the 7-Up bottling company, Eresonyen Primary School and University of Benin main Campus should be re-designed and re-constructed.
ii. Like other developed nations, policy should be developed for the design and construction of speed bumps on any road by appropriate department of the government for improved operational efficiency and safety. Such departments should ensure optimum compliance of speed bumps to stipulated height, length, widths, spacing, signage, materials and locations.
iii. Speed bumps should be considered on highway where concentrated generators of pedestrian activity, activities along and across the streets, and sensitive land uses are present for possible prevention of any unlawful placement of the device.
iv. The use of a rubber material for temporary testing of the effect, and allowing familiarity of the device with the pedestrian and drivers should be practiced to avoid aggravated accidents which may occur particularly if the drivers are not conversant with the road.
v. The reduction of speed by the speed bumps should not be an avenue for trading or commercial activities on the road to further impair traffic flow. Any erring offenders found should be arrested to face the penalty.

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