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Evaluation of Characteristics :Case Study of the Implemented Speed Humps in the City of Misurata

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Abstract— **Speed humps are one of the traffic calming methods that fall under the speed limit. In many countries, such devices have been the subject of careful investigations (to assess their effectiveness and disadvantages), and this has resulted in several modifications in their design to improve their performance. On the contrary, no systematic and scientific studies have been carried out on Libyan installations. This study aims to examine and classify the implemented speed humps in the city of Misurata and compare them with international standards. The sample for this study consists of 62 bumps installed in the city of Misurata. Based on the results obtained from the sample and according to the Institute of Transportation Engineers ITE standards, it was found that 13% can be classified as short type (speed bump), 21% are smooth type (speed hump), and 66% are out of specification. It was also found that 34% of the sample did not include a warning sign in front. Statistical analysis was carried out to evaluate the distance between the bump and the intersection and the distance between the bump and the warning sign, and it was found that the range between the largest values and the smallest values is very large for both distances, which indicates randomness in implementation and a lack of specific specifications.**

Index Terms: **Speed humps, Traffic calming, Institute of Transportation Engineers, Journey time.**

I. INTRODUCTION

Traffic calming measures are quite common in modern society. The main purpose of traffic calming measures is to reduce speed and create a safer traffic environment.[1] Traffic calming methods are a wide range of engineering solutions and "physical" procedures prepared by the engineers of the Traffic and Road Safety Department [2, 3], which include a set of modifications to the engineering design of the road, and the installation of barriers. And other engineering treatments, which encourage or force drivers to drive slower, and reduce traffic volumes, to raise safety on the street [4, 5].

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Raising a portion of a road surface popularly known as vertical deflections techniques such as speed bumps, speed humps, speed cushions, and speed tables can create discomfort for drivers while traveling on that portion. Both the height and the steepness of the portion affect the severity of vehicle displacement which forces the driver to slow down. Of all the traffic calming measures mentioned above, speed humps had gained acceptance as the best traffic calming device by several countries including Libya [6–7].

In Libya, there are an unlimited number of randomly unauthorized speed humps/bumps on almost every road, which could cause adverse effects on the road users and the surrounding environment [6]. Several studies were conducted to assess the effect of installing speed humps in the world roads on the pavement condition based on field data [8–10]. It was found that the presence of speed-humps has a great effect on the pavement conditions, and it could result in traffic safety problems and more fuel consumption, as well [8]. In terms of mobility, Hashim et al. [10] found that the presence of speed-humps significantly increased both the travel times and the delays for different times of the day, based on field observations of 20 km two lanes, two-way road, using GPS measurements. Furthermore, the installing of speed humps increases the response time of the fire and emergency vehicles [11].

Many researchers reported speed reductions of about 18-20% [12] while using speed humps. It was also concluded that speed reduction mainly depends upon the spacing of the speed humps [13,14]. The optimal spacing of speed humps as given by the Indian Road Congress (IRC) is about 100-120m. Even though speed humps are effective in reducing vehicular speed and high cut-through traffic volume, there are considerable disadvantages associated with them which often overshadow their benefits. Speed Hump is known to increase the journey time, passenger discomfort, maintenance cost of the vehicle, increase in environmental pollution and cause accidents. A study conducted revealed that speed hump causes a delay of 10sec per hump [15].

The failure to install speed-reducing measures on certain streets may involve greater safety concerns. Higher speeds are inappropriate in locations such as residential areas, not only because the risk of accidents increases but also there are strong links between the severity of pedestrian injuries and vehicle speed [16]. However, many concerns have been voiced about road humps, particularly the effects on emergency response times and maintenance operations, as well as the fact that if they are not designed properly, they can create unwanted noise and vibrations. Successful road hump designs have to meet all the following objectives: (1) reduce speed, (2) produce acceptable levels of discomfort for vehicle occupants, (3) result in no vehicle damage, and (4) maximize overall road safety [16].

II. OBJECTIVEES OF THE STUDY

The large number and randomness of the bumps in addition to the different types implemented on the streets of the city of Misurata has caused road users to question the extent to which they comply with the standards or not, because of the large number of traffic problems, which calls for scientific research to find out the causes of this problem and propose solutions to it, thus this study aims to:

1. Search for international specifications and standards approved in the design and implementation of bumps.
2. A field survey of all the bumps implemented on the main roads by creating a table to collect the important parameters in the design of the bumps, which include the geometric dimensions and drainage paths in addition to the traffic control devices.
3. Classifying the bumps and conducting a statistical analysis to reach reliable conclusions that contribute to the description and solution of the problem.

The bumps will be evaluated and compared according to the locations and requirements for the implementation of the bumps.Most agencies recommend the implementation of the bumps on local streets and collector roads that have problems related to excessive speed. Some specifications specify the dimensions of the drain paths, reflectors in addition to the location in which the warning sign should be placed, which is generally related to the 85th speed. Table (1) summarizes the dimensions of the bumps and distance requirements according to the specifications of the American Institute of Transportation Engineers ITE and Saudi General Specifications for Road Construction.

Table 1. Dimensions of bumps and distance requirements used in the study [5, 17, 18]

Type of Bump	**Length**		**High**	
	Meter (m)	Feet (ft)	Millimeter (mm)	Inch (in)
Speed Bump	1 - 0.3	3 -1	152 - 76	6 -3
Speed Hump	4.3 -3.7	14 -12	90 -76	3.5 -3
Speed Table	6.7	22	90 -76	3.5 – 3
Distance from the intersection (m)	20			
Warning Sign Distance (m)	110 - 80			
Reflectors in front of bumps (m)	2.50 – 0.50			

III. METHODOLOGY

In this part, a field survey was conducted for 62 bumps on the main roads in the city, namely the ring roads: the second, the third, and the fourth, in addition to Qasr Ahmed Street. The choice was made on these roads because the bumps in them have been implemented by many of the official authorities of the state, and therefore the survey of these bumps is sufficient for the evaluation process and gives an indication of the extent to which the official authorities adhere to the specifications and standards, unlike if the bumps on the sub-streets were evaluated Implemented by the people. The process of data collection was through observation and taking the required measurements with the regular, laser, and lead tape and writing them down in Table (2).

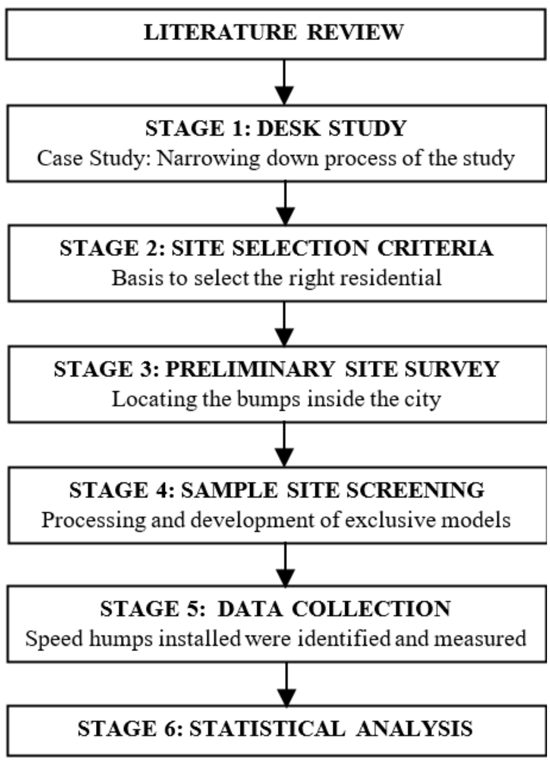
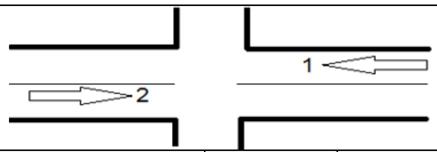


Figure 1. Methodology flowchart.

Table 2. Bumps data collection form



	Direction (1)	Direction (2)	Notes
bumps data			
Length (m)			
Height (m)			
Distance from bump to an intersection (m)			
drainage holes	☐Finding ☐Not Finding	☐Finding ☐Not Finding	
If drainage holes find	☐Right road ☐Left road	☐Right road ☐Left road	
Traffic control devices			
Paint the bump with a reflective material			
Reflectors in front of the bump			
Distance from the bump (m)			
warning sign	☐Finding ☐Not Finding	☐Finding ☐Not Finding	
If a warning sign finds	☐Right road ☐Left road	☐Right road ☐Left road	
Distance from the bump (m)			

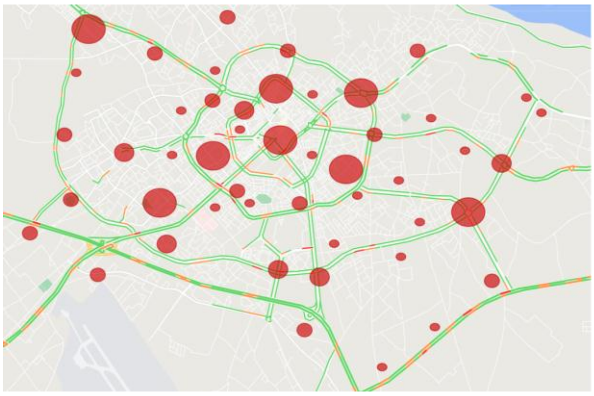


Figure 2. Residential area and neighborhood center for central Misurata.

Figure. 1 illustrates a flowchart that shows each of the processes involved in this research. The Desk Study stage includes the identification process or the narrowing-down process of the study area through various maps such as road maps, land use maps, and topographical maps. Misurata was chosen as the study area because with a large population, the results from the study can be effective in researching the effect of the speed hump from the various drivers' perceptions and behaviors.[19]

After collecting the necessary data, the classification process was carried out according to the standards of the Institute of Transportation Engineers, which classified the bumps into three sections: speed bump (short), speed humps (smooth), and speed table (flat). Then statistical analyzes of the most effective distances, which are from the bump to the intersection, from the bump to the warning sign.

IV. RESULTS

After collecting the data, the process of analysis, calculations, results are presented and discussed. Through the collected data, the bumps were classified according to the standards of the American Institute of Transportation Engineers, as shown in Figure 3, where it appears that 13% of the sample was of the speed bump type (short) and 21% of the speed hump type (smooth) and 66% out of specifications, and it is worth noting that the percentage of speed table bumps (flat type) is 0%, meaning that this type of bumps are not implemented inside the city of Misurata, although this type is used as a pedestrian crossing and therefore its absence is considered a dangerous indicator of not taking care of traffic safety, especially that some points in the streets of the study area are considered attractive areas for pedestrians due to the commercial activities in them. What is striking is the presence of 13% of the speed bump type(short) implemented on roads classified as non-local.

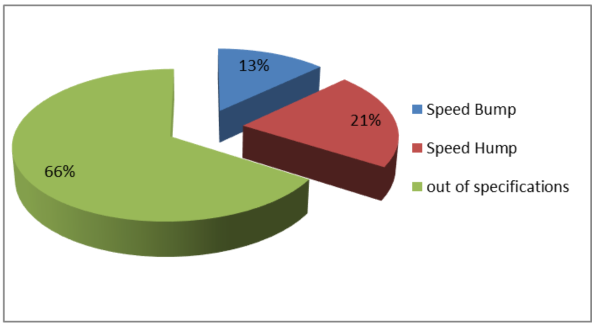


Figure 3. Classification of bumps according to ITE.

The drainage requirements were met by approximately 40% of the bumps, as shown in Figure 4, with drainage paths ranging in length from 5 cm to 45 cm being installed between the bumps and the edge of the road, and 60% of the bumps were implemented with drainage paths ranging in length from 5 cm to 45 cm being installed.

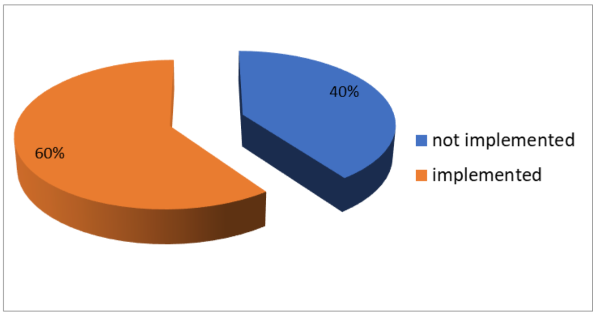


Figure 4. Drainage requirements.

Regarding the distance between the bump and the intersection, we can see from Figure 5 that the percentage of bumps that conform to the specifications and are at least 20 meters away from the intersection is approximately 36 percent, even when we disregard long distances and extreme values. However, statistical analysis can be used to extract distances that have been implemented in statistically significant proportions, as shown in Table 1. Several statistical measures are presented in Table 3 that are useful in describing and summarizing the data on the distance between the bump and the intersection.

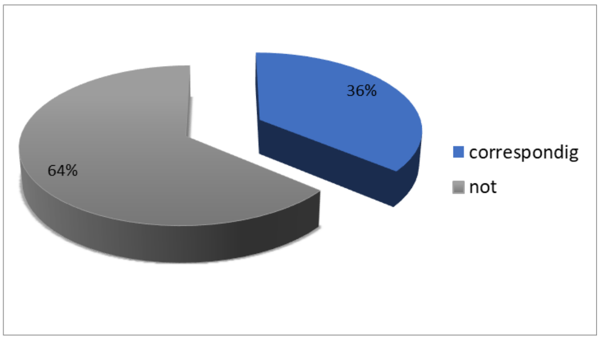


Figure 5. The distance between the bump and the intersection.

Table 3. Statistical Measures

Mean	17.5
Standard Deviation	14.1
Minimum	2.8
Maximum	67.6

It can be seen vividly the large dispersion of the data through these measures, which is evident in the large standard deviation value, which was close to the arithmetic mean, as well as the disparity between the largest value of 2.8 meters and the smallest value of 67.6 meters, and the large standard deviation value, which was close to the arithmetic mean. Figure 6 depicts a histogram that can be used to gain a better understanding of the nature of the data being presented.

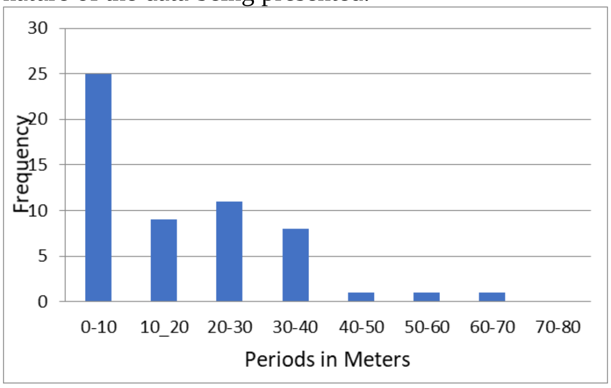


Figure 6. Histogram of the distance of the bump from the intersection.

The histogram reveals that the repetition period from 2.8 meters to 10 meters is the most frequent, accounting for 44.64 percent of all bumps and that 25 of the 56 bumps were implemented with a distance ranging from 2.8 meters to 10 meters, which is outside the specifications. There are significant percentages for distances from 10 to 40 meters, while the intervals from 40-50, 50-60, and 60-70 meters were the least frequent and in small proportions, accounting for only one bump each of these intervals.

Once the results of traffic control devices, the most important of which is painting the bumps with reflective paint, have been analyzed, it is discovered that they are virtually non-existent in most cases. When it comes to reflectors, Figure 7 shows that 39 percent were not installed, while 58 percent did not meet the distance standards (50-150 cm), and 3 percent were installed in the proper location.

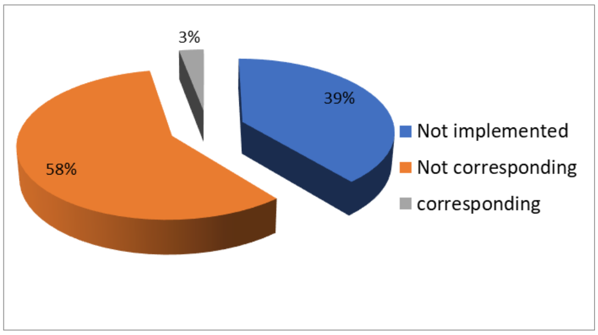


Figure 7. The reflectors in terms of implementation and required distance.

The results show in Figure 8 that there is 34 percent of bumps do not have a warning sign, while 66 percent of the bumps have warning signs that have been activated. Figure 9 also shows that the percentage of bumps that complied with the standards for 80-110 meters was 7 out of 41 bumps, or 17 percent, while approximately 83 percent were outside the specifications. Note that the rate of conforming to specifications is 7 out of 62 bumps, or 11.3 percent of the total sample, which is an excellent result.

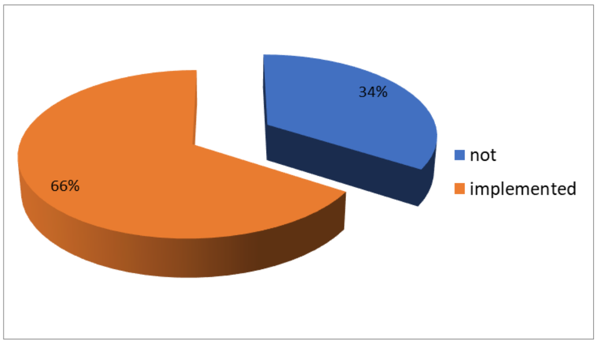


Figure 8. The distance between the warning sign and the bump.

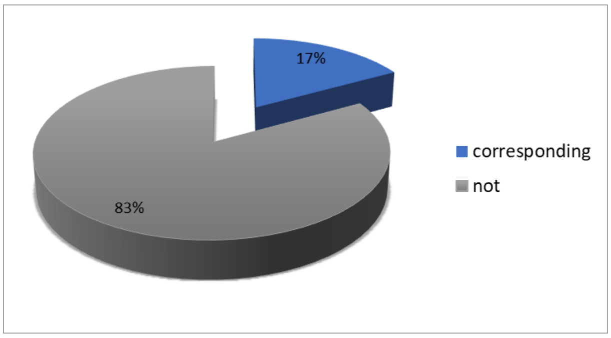


Figure 9. Distribution of the implemented ratio (66%).

As was the case previously, it is possible to obtain some statistical measures that aid in the understanding and interpretation of these numbers, such as:

Table 4. Statistical Measures for

Mean	80.2
Standard Deviation	37.7
Minimum	11.5
Maximum	168.7

In Table 5, we see that the minimum distance between the bump and the traffic sign was 11.5 meters, and the maximum distance was 168.7 meters, which indicates a significant discrepancy between the data and the expectations. We should point out that the standard deviation was 37.7, which indicates that the data was dispersed widely across the distribution. The following information can be represented in a histogram.

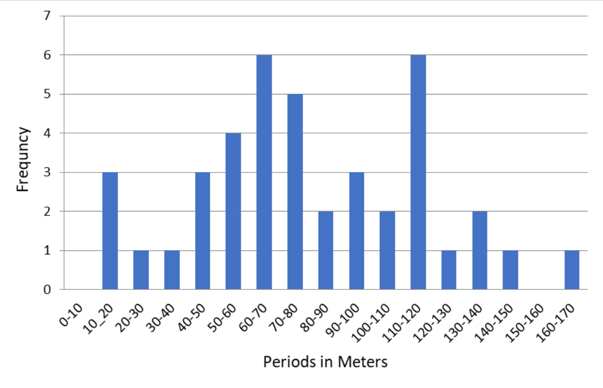


Figure 10. Histogram of the distance from traffic sign to the bump.

It appears that the percentage of conformity with standards 80-110 meters was 7 out of 41 bumps, or 17 percent, according to the data in Figure 10, which has already been explained in detail. From the histogram, we can see that the period between 120 and 110, as well as the period between 60 and 70, are equal, indicating that there is a certain amount of randomness in the implementation. The percentages of 2.44 percent for the periods 20-30, 30-40, 120-130, 140-150, 160-170 represent the same percentages of 2.44 percent, which also indicates randomness and non-compliance with certain specifications, as well as a range of other factors.

IIV. CONCLUSION

- According to ITE specifications, 13% of the bumps can be classified as a speed bump, 21% as to speed humps, and 66% outside specifications.
- Regarding the drainage requirements, it was found that about 40% of the bumps had no drainage paths, while 60 percent had drainage paths with different dimensions ranging from 4 cm to 45 cm.
- Coating the bumps with reflective paint is almost non-existent.
- About 39% of the bumps were executed without reflectors, while 58% did not meet the criteria for a distance of 50-150 cm.
- There is a large discrepancy in the implementation of the bumps at the intersections and this is clear through the large standard deviation value and the discrepancy in the range between the largest value of 2.8 meters and the smallest value of 67.6 meters. In addition, 44.64% of the bumps were executed with a distance of 2.8 to 10 meters, while the standards stipulate that the bump be 20 meters away from the intersection.
- 34% of the bumps do not have a warning sign, while the percentage of executed signs was 66%. Also, the percentage of conformity with the standards 80-110 meters was 7 out of 41 bumps, or 17%, while about 83% were outside the specifications. It is worth noting that the percentage of conforming to the specifications is 7 out of 62 bumps, 11.3%.
- There is also a large discrepancy in the distance of the warning sign from the bump through the value of the standard deviation and the range between the lowest value of 11.5 meters and the largest value of 168.7 meters, which means randomness in the implementation of the traffic sign and non-compliance with certain specifications.

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