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Noise Emission Characterization of Different Commercial Motorcyles in Nigeria for Appropriate Management Strategies

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Abstract

The costs and benefits of motorcycle noise reduction have received less attention in developing countries despite the adverse effects of inordinate exposure to noise. The first step in noise management is to gain an understanding of the types of noise generated in order to design an appropriate mechanism to reduce the noise. Therefore, this study characterized the noise emitted by different models of commercial motorcycles in Benue State, Nigeria. Five models of motorcycles - Motobi, Bajaj Boxer, CY90 Jianshe, Honda 110 and Jincheng, were studied. The noise level data were collected under two main operating conditions; idle (Zero and full throttles modes) and moving motorcycles at 30 km/h; 40 km/h or 50 km/h (with and without loads). The result showed that Jincheng motorcycles emitted the highest noise level with an average mean of 74.00 dB (A) (SD = 2.62) at zero throttle and 80.00 dB (A) (SD = 2.54) at full throttle. The paired samples *T*-tests between the zero throttle and the full throttle mode showed significantly higher noise emission level for full throttle operation when compared to zero throttle ($p<.001$). The used Jianshe and Jincheng motorcycle models emitted noise above the World Health Organization recommended standard limit of 70-75 dB for noise from motorcycles. While Jincheng motorcycle model with silencer and CY90 Jianshe and Jincheng motorcycle model without silencer emitted noise above 90 dB(A), which is the standard recommended by the US Environmental Protection Agency (FEPA). This study will help the relevant authorities to develop appropriate noise emission management strategies.

Keywords: noise emission, motorcycle models, idle mode, sound muffles, noise reduction

INTRODUCTION

A motorcycle often referred to as a bike, motorbike, or cycle is a twin-engine vehicle which varies widely in their design to suit several different purposes: long-distance travel, commuting, cruising, sports and off-road riding (Foale, 2006). Classification of motorbike is based on the description of how the bikes will be used, the intention of the designer, and a combination of both (Broughton and Walker, 2009). However, six main categories widely recognized are: cruiser, sport, touring, standard, general purpose, and dirt bike. Regardless of the category of motorcycle, several types of noise affect a rider's noise perception of a motorcycle, such as engine and transmission noise, intake and exhaust noise, tire-induced noise, and wind noise, as well as the vibration quality a rider experiences (Jay, 2007). In the urban centers, traffic noise is a source of concern and resentment (González, 2011). This traffic noise is caused by the ever-increasing demand for goods, energy and passenger transport. Many Nigerian citizens are exposed to unhealthy levels of noise. These values can affect health and well-being, the effects of which affect working and living conditions and, consequently, the economy.

Noise pollution from the motorcycles has become a serious problem for stakeholders in both the transport and engineering sectors. Emissions from engines vary as engines age and go through the routine maintenance cycle. Depending on its quality and intensity, this emission can translate to noise. (Dasarathy, 2015). Authorities in developed countries, recognizing the danger related to hearing noise levels, have pushed manufacturers and other stakeholders to sell quiet products to meet customer demands (Lu and Jen, 2014). In addition to attractive design and high-performance requirements, noise and sound perception are considered valuable attributes for increasing motorcycle marketing competitiveness and satisfaction. In particular, the sound pressure level emitted by the drive train and the associated distribution of the application components conveys an overall impression of the quality of a motorcycle. The noise emission is expected to meet the relevant legal noise limits and also improve the sound quality of motorcycles (Genuit, 2004).

Over the past few decades, several studies have been conducted to improve the perception of noise in passenger car interiors (Jay, 2009), but few researches have addressed the noise and sound quality of motorcycles (Schuhmacher and Tcherniak, 2009). Passenger cars compared to motorcycles have less control over their noise emissions due to their exposed drive train and limited space. Karan (2009), listed a range of operating factors that affect the noise emission levels in motorcycles as wet road surface, load, tread-wear status of the motorcycle tyre, temperature

variations and muffler condition. Among the ways of controlling emissions from automobiles is to provide an additional area for oxidation or combustion to occur. This additional area is called the catalytic converter, which is usually housed in the exhaust/muffler on motorcycles (Al-Hasan, 2003). The motorcycle exhaust system with the help of the muffler, also reduces noise. The catalytic converter used in motorcycles works together with a muffler.

The costs and benefits of motorcycle noise reduction have received less attention in developing countries like Nigeria. Nonetheless, exposure to environmental noise is recognized as one of the major environmental issues in today's society. The first step in noise management is to gain an understanding of the types of noise generated in order to design an appropriate mechanism to reduce that noise. For this reason, this research attempts to evaluate the noise emission characterization of various commercial motorcycles (standard) in a city in Nigeria. Therefore, this would allow stakeholders in the transportation and environmental sectors of Nigeria's economy to regulate the types of motorcycles manufactured and imported for use in the country. It will also help the relevant authorities to develop other appropriate management strategies.

MATERIALS AND METHODS

Five (5) models of motorcycles were studied. The motorcycles use Premium Motor Spirit (PMS) as the energy source and are used for commercial transportation purposes in Makurdi, Benue State. They include, Motobi, Bajaj Boxer, CY90 Jianshe, Honda 110 and Jincheng. The five models of motorcycles examined had a kick start mechanism as the engines were four-stroke engines, but for CY90 Jianshe that has a two-stroke engine. Other specifications such as the tyre sizes, length and height dimensions, engine capacity and mileage are presented in Table 1.

Table 1. The specifications of the commercial motorcycles

Motorcycle Type	Engine capacity (cc)	Max power (Kw)	Tyre size (mm)	Length (mm)	Height (mm)	Mileage (km/h)
Bajaj boxer	124.10	8.50	2.75-17; 300 -17	2016	1055	70.00
Jincheng	144.80	8.83	2.75-17; 300 -17	2050	1100	90.00
Honda 110	109.19	8.30	2.75-17; 300 -17	1905	1060	80.00
Motobi	125.00	7.90	2.75-17; 300 -18	2108	1180	80.00
CY90 Jianshe	132.20	8.55	2.75-17; 250-17	1807	980	70.00

The following instruments were used for data collection from the five models of motorcycles under study (Motobi, Bajaj Boxer, CY90 Jianshe, Honda 110, Jincheng):

i. Speedometer model Rs11.500 manufactured by Kolkata, West Bengal (India) was used to measure the function speed of rotation of the wheels in revolutions per minute (rpm). Specified accuracy is 23℃ ± 5℃, <75% R.H. ± 0.02% of reading + 1 dgt 0.02% of reading + 1 dgt.
ii. Noise levels, model GM 1352 manufactured by Shenzhen Jumaoyuan Science and Technology Co., Ltd., China was used for the noise levels measurement. The specifications of the noise level meter are a measurement range of 30 - 130 dBA, at a 0.1 dB resolution, and limited to the frequency range of 31.5 Hz - 8 KHz.
iii. A handheld digital professional (LCD) stopwatch model PC-396 (Shenzhen super deal Co, Ltd, China) was used for recording the time interval for the nose emission level test
iv. A digital hygrothermometer manufactured by At Finger Technology Co., Ltd China (Fujian) measured and displayed the environmental air temperature of the study environment. Its measurement ranges are -50°C - 70 °C for temperature (in Fahrenheit -58 ~ 158 °F) and 10 - 99% for relative humidity. The measurement accuracy is ±1 °C for temperature evaluation. The environmental air temperature of the study environment was put in check using hygrothermometer as Karan (2009) study stated that the temperature variations affect noise emission levels (although not significant)

The noise level data collection method developed to generate noise from motorcycles were under operating conditions; idle (throttle and full throttles modes) and moving motorcycles at 30 km/h; 40 km/h or 50 km/h (with and without loads) the dead weight used was a mass of 30kg and human load mass of 75 kg. The method involves motorcycle operating conditions that are realistic and would result in the highest noise level consistent with normal riding and this allowed the noise emission to be reproducible. The test was based on accelerating the vehicle at full throttle from a started driving condition. The test was conducted in a wide-open space with a radius of about 25 m in an open environment. Mostly commercial motorcycle operates on minor/street roads (local roads) as such the consideration of the set standard of 25 m which is a setback is the specific standard horizontal distance of a building or other structure is meant to leave from a street or road (Azodo et al., 2018; Okafor, 2020). Two categories of the five models of the motorcycles, old and new, were assessed. Below are the specified categories of conditions for which each of the motorcycles were tested for noise emission levels:

i. Two idle modes, at no throttle and at full throttle with the silencer and without silencers when the motorcycles were fired up.
ii. The noise for the moving motorcycles used for the experiment was operated under two different conditions (3rd and 4th gear) at 30 km/h; 40 km/h or 50 km/h to determine how much noise is released into the environment; with a load and without a load.
iii. The effect of dead weight and human body on the noise emission levels.

The initial environmental noise level was measured and noted at a range of 32-35 dB (A) so as to note the implication of the motorcycle noise emission level to the environment. The test was carried out in the early hours of the morning between the hours of 6:00-7:00 am to avoid environmental noise interference from human activities. The measurements were taken and recorded fifteen times at the intervals of 2 minutes for each category designed for the noise level assessment and data collection for the motorcycle operations. Multiple independent *T*-tests were used on the noise level data collected for comparisons between;

a) Used and new motorcycles during the idle modes no throttle and at full throttle
b) The idle mode operation of the motorcycles with the silencer and without silencers.

An analysis of variance test was conducted on the noise levels measured from each of the motorcycles data for 3rd and 4th gear at 30 km/h; 40 km/h or 50 km/h for the moving motorcycles. The level of significance was set at $p < 0.05$. The independent variable was the speed of rotation and the dependent variable was the measured noise level. Analyses were carried out using the statistical package for social science (SPSS) version 20.0 and Microsoft Excel 2016.

RESULTS AND DISCUSSIONS

The results of the various noise emission level tests of five model of motorcycles assessed are shown in Tables 2 to 5. Tables 2 and 3 contains the noise emission levels dB(A) for new motorcycles at idle mode for both zero and full throttle, with silencer and without silencer respectively**.**

Table 2. Descriptive statistics of the noise emission level from the new motorcycles with silencer

Descriptive statistics	**Zero throttle**					**Full throttle**				
	Min	**Max**	**Mean**	**SD**	**SEM**	**Min**	**Max**	**Mean**	**SD**	**SEM**
Motobi	62.00	72.00	67.00	3.34	0.86	73.00	81.00	77.00	2.04	0.53
Bajaj Boxer	58.00	68.00	63.00	3.07	0.79	69.00	78.00	74.00	2.33	0.60
CY90 Jianshe	69.00	78.00	73.00	2.67	0.69	75.00	84.00	79.00	2.62	0.68
Honda 110	58.00	66.00	62.00	2.27	0.59	68.00	77.00	73.00	2.59	0.67
Jincheng	69.00	79.00	74.00	2.62	0.68	76.00	85.00	80.00	2.54	0.65

Table 3. Descriptive statistics of the noise emission level from the new motorcycles without silencer

Descriptive statistics	Zero throttle					Full throttle				
	Min	Max	Mean	SD	SEM	Min	Max	Mean	SD	SEM
Motobi	67.00	76.00	71.00	2.33	0.60	77.00	86.00	81.00	2.56	0.66
Bajaj Boxer	65.00	75.00	70.00	3.09	0.80	72.00	81.00	77.00	2.78	0.72
CY90 Jianshe	74.00	82.00	79.00	2.27	0.59	78.00	87.00	82.00	2.42	0.62
Honda 110	64.00	74.00	69.00	2.78	0.72	71.00	81.00	76.00	2.95	0.76
Jincheng	75.00	85.00	80.00	3.07	0.79	79.00	88.00	84.00	2.80	0.72

The emission noise levels data from the assessed motorcycles were subjected to data analysis. The result of the descriptive statistical analysis carried out on the noise emission level from the new motorcycles on idle operation mode for zero and full throttle with the silencer average showed that Jincheng emitted the highest noise level with an average mean of 74.00 dB (A) (SD = 2.62) at zero throttle and 80.00 dB (A) (SD = 2.54) at full throttle (Table 2). This was followed by CY90 Jianshe motorcycle model which recorded 73.00 dB (A) (SD = 2.62) as its own average mean at zero throttle and 79.00 dB (A) (SD = 2.62) at full throttle. The lowest noise emission level was recorded against motorcycle of Honda 110 with zero and full throttle values as 62.00 dB (A) (SD = 2.27) and 73.00 dB (A) (SD = 2.59), respectively (Table 2).

When the motorcycles were tested for noise emission levels without silencer, similar trend of results was obtained as the highest noise emission levels at zero and full throttle were recorded against Jincheng motorcycle model with mean values of 80.00 dB (A) (SD = 3.07) and 84.00 dB (A) (SD = 2.80). Whereas the lowest noise emission levels at zero and full throttle were recorded against Honda 110 motorcycle model with mean values of 69.00 dB (A) (SD = 2.78) and 76.00 dB (A) (SD = 2.95) (Table 3). The highest value of noise emission level obtained from Jincheng motorcycle model in this study when compared to the other motorcycle model is similar to the outcome of Karan (2009) study who compared five different motorcycles for quick response sound pressure levels at two operating conditions, 3rd and 4th gear, using the zero and wide-open throttle. Tables 4 and 5 contains the noise emission levels dB(A) for used (old) motorcycles at idle mode for both zero and full throttle, with silencer and without silencer respectively**.**

Table 4. Descriptive statistics of the noise emission level from the used motorcycles with silencer

Descriptive statistics	Zero throttle					Full throttle				
	Min	Max	Mean	SD	SEM	Min	Max	Mean	SD	SEM
Motobi	72.00	79.00	75.00	1.46	0.38	78.00	88.00	83.00	3.07	0.79
Bajaj Boxer	71.00	80.00	76.00	2.70	0.70	79.00	89.00	84.00	3.16	0.82
CY90 Jianshe	77.00	87.00	82.00	2.51	0.65	84.00	93.00	89.00	2.30	0.59
Honda 110	72.00	79.00	75.00	2.56	0.66	78.00	87.00	83.00	2.30	0.59
Jincheng	79.00	88.00	83.00	2.51	0.65	89.00	95.00	92.00	1.60	0.41

Table 5. Descriptive statistics of the noise emission level from the used motorcycles without silencer

Descriptive statistics	Zero throttle					Full throttle				
	Min	**Max**	**Mean**	**SD**	**SEM**	**Min**	**Max**	**Mean**	**SD**	**SEM**
Motobi	74.00	83.00	79.00	2.24	0.58	82.00	90.00	86.00	2.36	0.61
Bajaj Boxer	76.00	83.00	80.00	2.14	0.55	82.00	92.00	87.00	2.90	0.75
CY90 Jianshe	78.00	87.00	83.00	2.51	0.65	89.00	98.00	94.00	3.42	0.88
Honda 110	75.00	85.00	80.00	2.90	0.75	81.00	91.00	86.00	3.00	0.77
Jincheng	82.00	92.00	86.00	2.95	0.76	92.00	102.00	97.00	3.21	0.83

The highest noise emission level of 83.00 dB (A) (SD = 2.51) and 92.00 dB (A) (SD = 1.60) from the five models of motorcycles assessed were recorded against Jincheng model of motorcycle (Table 4). The lowest noise emission level was recorded against Motobi and Honda 110 models of motorcycle at zero throttles with an average mean values of 75.00 dB (A) (SD = 1.46) and 75.00 dB (A) (SD = 2.56) respectively whereas at full throttle, values of 83.00 dB (A) (SD = 3.07) and 83.00 dB (A) (SD = 2.30) respectively when the test was conducted with silencer (Table 4). When the used motorcycles were tested without silencers for the noise emission level, Jincheng recorded the highest value of 86.00 dB (A) (SD = 2.95) at zero throttle and 97.00 dB (A) (SD = 3.21) at full throttle (Table 5). The lowest noise emission levels from the motorcycles without silencer was recorded against Motobi motorcycle model with an average mean value of 79.00 dB (A) (SD = 2.24) at zero throttle and the lowest noise emission levels from the motorcycles without silencer at full throttle is recorded against Motobi model and Honda 110 with an average mean values of 86.00 dB (A) (SD = 2.36) and 86.00 dB (A) (SD = 3.0) respectively. Following the health criteria for acceptable risk of noise exposure limits by the World Health Organisation which is 85 dB(A) + 5dB(A) for noise exposure, the used CY90 Jianshe and Jincheng motorcycle models assessed emitted noise well above the regulations and recommended limits for operations (WHO, 1980). However, all recorded mean values were below 90 dB(A), which is the standard recommended by the US Environmental Protection Agency (FEPA) except Jincheng motorcycle model with silencer and CY90 Jianshe and Jincheng motorcycle model without silencer (1991).

The noise emission level data from the new motorcycles obtained for the five models of motorcycles was compared with the used models of the motorcycles to ascertain if the usage duration affects the noise emission level characteristics. Paired samples *T*-test used to compare the new motorcycle status and the used motorcycle status for the five models of the motorcycles assessed showed negative *T*-value at $p < 0.01$ (Table 6). This indicates a significant difference between noise levels emitted by the new and the used motorcycle. This result implies that usage increases the noise emitted by the motorcycles irrespective of the model. The result obtained in

this study agreed with a study by Dasarathy (2015), which claimed that the emissions from engines vary as engines age and go through the routine maintenance cycle.

Table 6. Paired sample *T*-test for new and old motorcycle models noise emission levels at idle motorcycle operation mode

Motorcycle models	Status	Descriptive statistics		*T*-test for equality of means		
		Mean ± SD	SEM	T	Df	*p*-value
Motobi	New	75.50 ± 6.30	0.81	-8.08	59	0.00
	Used	79.25 ± 5.92	0.76			
Bajaj Boxer	New	74.25 ± 8.05	1.04	-7.45	59	0.00
	Used	78.50 ± 6.71	0.87			
CY90 Jianshe	New	80.75 ± 6.31	0.81	-6.95	59	0.00
	Used	84.50 ± 6.30	0.81			
Honda 110	New	73.25 ± 7.92	1.02	-8.97	59	0.00
	Used	77.75 ± 6.85	0.88			
Jincheng	New	82.25 ± 6.94	0.90	-8.13	59	0.00
	Used	86.75 ± 7.00	0.90			

In the operation mode of the motorcycles, being a fuel-powered internal combustion engine takes in air from the atmosphere, and the combustion process releases chemical energy from the energy stored in the fuel. About 20% of the released energy is used to propel the vehicle, while the remaining 80% is lost through friction, air resistance and accessory operation. The higher the amount of energy released, the greater the frictional force and drag, which increase the motorcycle's noise levels due to engine loading (Toyota Motor Sales, 2016). The statement was substantiated through a paired *T*-test carried out on all the motorcycles (Motobi, Bajaj Boxer, CY90 Jianshe, Honda 110 and Jincheng). The paired samples *T*-tests for each of the five models assessed between the zero throttle and the full throttle showed statistically significantly higher mean noise emission level values during full throttle operation when compared to zero throttle with $p < 0.01$ (Table 7). The groups' means are significantly different as the *p*-value is less than 0.05. This implies that residential noise emission levels increase the due to engine loading.

Table 7. Paired sample *T*-test noise emission levels at idle motorcycle operation mode for zero and full motorcycle engine operation for the five models of motorcycles assessed

Motorcycle models	Throttle operation	Descriptive statistics		*T*-test for equality of means		
		Mean ± SD	SEM	T	Df	*p*-value
Motobi	Zero	73-00 ± 5.10	0.66	-19.02	59	0.00
	Full	81.75 ± 4.12	0.53			
Bajaj Boxer	Zero	72.25 ± 7.01	0.91	-16.31	59	0.00
	Full	80.50 ± 5.93	0.77			
CY90 Jianshe	Zero	79.25 ± 4.62	0.60	-10.85	59	0.00
	Full	86.00 ± 6.49	0.84			
Honda 110	Zero	71.50 ± 7.25	0.94	-14.44	59	0.00
	Full	79.50 ± 5.90	0.76			
Jincheng	Zero	80.75 ± 5.24	0.68	-12.36	59	0.00
	Full	88.25 ± 7.17	0.93			

The motorcycles being spark ignition engine, as the piston moves upward during the compression stroke, a rapid pressure increase occurs inside the cylinder, causing the air-fuel mixture to superheat. During this process, some of the energy lost to friction in the cylinder contributes significantly to the amount of noise emitted from the motorcycle. The paired sample *T*-test used to determine the effectiveness of the sound muffles in each of the motorcycle models assessed showed that the motorcycle operations with the silencer attached had significant lower ($p < 0.01$) noise emission level as compared to the noise emission levels of the motorcycles when there were no silencers (Table 8). This implies that the silencers have muffling effect on the noise emission levels produced from the motorcycles. This study agreed with Close & Wesler (2011) study that absence of exhaust muffling is a significant factor that contributes to noise in motorcycles which accounts for the throaty roar of motorcycles.

Table 8. Paired sample *T*-test noise emission levels at idle motorcycle operation mode for muffling effect of the silencer during the motorcycle engine operation

Motorcycle models	**Muffling effect**	**Descriptive statistics**		***T*-test for equality of means**		
		Mean ± SD	**SEM**	**T**	**Df**	***p*-value**
Motobi	With silencer	74.00 ± 6.00	0.77	-13.80	59	0.00
	Without silencer	80.75 ± 4.77	0.62			
Bajaj Boxer	With silencer	71.00 ± 5.97	0.77	-20.67	59	0.00
	Without silencer	81.75 ± 4.97	0.64			
CY90 Jianshe	With silencer	78.25 ± 4.10	0.53	-15.14	59	0.00
	Without silencer	87.00 ± 5.56	0.72			
Honda 110	With silencer	70.00 ± 5.89	0.76	-21.06	59	0.00
	Without silencer	81.00 ± 4.87	0.63			
Jincheng	With silencer	79.50 ± 4.50	0.58	-17.29	59	0.00
	Without silencer	89.50 ± 6.03	0.78			

Motorcycles, in solving the mobility needs of many urban residents and rural people in the light of poor and inadequate public transport system, poor road conditions particularly those leading into the peri-urban areas where many people reside which are very far from the major cities conveys pillion passengers (one or two riders), goods and services (such as those employed by the courier companies to deliver their services to clients) (Dinye, 2013; Azodo, 2016). The characteristic effect of the load (dead weight) and passenger (human body mass) masses on the noise emission levels which the motorcycles convey were descriptively analyzed. Noise emissions level in 3rd gear ranged from 64.00 – 79.00 dB(A) without load and 50.00 – 68.00 dB(A) with load at 30 km/h (5.0 x 105 rpm). At 40 km/h (6.7 x 105 rpm) the noise emission level ranged from 52.00 - 75.00 dB(A) and 45.00 - 60.00 dB(A) with and without load, respectively. the ranges for

the noise emission levels of the motorcycles assessed at 50 km/h (8.3 x 105 rpm) with and without load, were 50.00 - 73.00 dB(A) and 36-59 dB(A), respectively (Table 9).

Table 9. Descriptive statistics of the noise emission level of motorcycles speed in 3rd gear with and without load

Motorcycle type	dB(A) at 5.0 x10^5rpm (30 km/h)		dB(A) at 6.7x10^5rpm (40 km/h)		dB(A) at 8.3x10^5rpm (50 km/h)	
	Without load	With load	Without load	With load	Without load	With load
Motobi	64.00	50.00	52.00	45.00	50.00	36.00
Bajaj Boxer	66.00	51.00	63.00	49.00	55.00	40.00
CY90 Jianshe	70.00	68.00	64.00	59.00	61.00	47.00
Honda 110	68.00	51.00	60.00	50.00	57.00	46.00
Jincheng	79.00	63.00	75.00	60.00	73.00	59.00

Table 10 shows the noise emissions of the five motorcycles in 4th gear with and without passenger (load). The noise emission in 4th gear was ranged from 47.00 - 60.00 dB(A) and 46.00 - 57.00 dB(A) at 30 km/h (5.0 x 105 rpm) with and without load, respectively. The noise emission in 4th gear was ranged from 44.00 - 58.00 dB(A) and 38.00 - 52.00 dB(A) at 40 km/h (6.7 x 105 rpm) with and without load, respectively. The noise emission in 4th gear was ranged from 42.00 - 49.00 dB(A) and 36.00 - 49.00 dB(A) at 50 km/h (8.3 x 105 rpm) with and without load, respectively. For all motorcycles it was observed that the noise emission was higher without load and decreased with increasing load on the motorcycles. The noise emissions also decreased with increasing speed from 30 km/h to 50 km/h. The results obtained in this study were below the maximum limit recommended by FEPA (90 dB (A)) and WHO (85 dB (A)).

Table 10. Descriptive statistics of the noise emission level of motorcycles speed with and without load

Motorcycle type	dB(A) at 5.0 x10^5rpm (30 km/h)		dB(A) at 6.7x10^5rpm (40 km/h)		dB(A) at 8.3x10^5rpm (50 km/h)	
	Without passenger	With Passenger	Without passenger	With passenger	Without passenger	With passenger
Motobi	47.00	46.00	45.00	38.00	42.00	36.00
Bajaj Boxer	50.00	48.00	47.00	46.00	44.00	37.00
CY90 Jianshe	53.00	49.00	48.00	48.00	46.00	44.00
Honda 110	48.00	48.00	44.00	42.00	43.00	40.00
Jincheng	60.00	57.00	58.00	52.00	49.00	49.00

Noise level in automobiles are affected by a variety of factors. Analysis was carried out to test if increasing speed of the motorcycles rises the noise emission at the third gear engagement for speed ratings of 30, 40 and 50 km/h. An analysis of variance test by comparing the mean square to an estimate of experimental error, raised statistical significance for the three categories (30, 40 and 50 km/h) of speed ratings at *p*-values less than 0.05. The results obtained for the noise emission

for the riding speeds of the motorcycles had a *p*-value less than 0.05, indicating that they are significantly different from zero at a 95% confidence level (Table 11). The effect of the riding speed on the noise emission levels of motorcycles as analyzed using the analysis of variance, gave a high F-value (44.66). The groups' means are significantly different because the *p*-value is less than 0.05. This result implies that motorcycle riding speed affects the noise emission levels. This study agreed with (Karan, 2009) that the noise level usually rises with increasing speed for all motorcycles at a slightly different rate.

Table 11. Analysis of variance for the effect of riding speed on noise emission level of the motorcycles

Characteristics	**Sum of Squares**	**Df**	**Mean Square**	**F-value**	***p*-value**
Between Groups	8427.00	2	4213.50	44.66	0.00
Within Groups	42171.50	447	94.34		
Total	50598.50	449			

CONCLUSIONS

This study characterized the noise emissions levels of five models of motorcycles for used and new motorcycles at idle mode both zero and full throttle, with silencer and without silencer**.** This study found different models of motorcycles emits varied noise levels. The different operation modes that affects the noise emission levels of the motorcycles include age status (new and used), idle modes (throttle and full throttles) and speed rating of moving motorcycles (30 km/h; 40 km/h and 50 km/h) and the load effect (with and without loads). The result of the descriptive statistical analysis carried out on the noise emission level from the new motorcycles on idle operation mode for zero and full throttle with the silencer average showed that Jincheng emitted the highest noise level with an average mean of 74.00 dB (A) (SD = 2.62) at zero throttle and 80.00 dB (A) (SD = 2.54) at full throttle. The concerned authority should enact and monitor legislation obliging all commercial motorcycles user's compliance (used and old) with the noise emission level recommended by international bodies such as WHO and FEPA (WHO, 2000).

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