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# Evaluation of Physicochemical Parameters, Total Bacteria Count and some Heavy Metal Levels in Soil from Automobile Workshop Activities at Nnewi Local Government Area, Anambra State, Nigeria

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**ABSTRACT:** Disposal of used motor oil and chemical substances on land leads to loss in soil quality by minimal abundance and variety of microorganisms in soil. The objective of this paper was to evalaute the physicochemical parameters, total bacteria count and some heavy metal levels in soil from automobile workshop activities at Nnewi Local Government Area, Anambra State, Nigeria. Using field survey and appropriate standard laboratory analyses, the results showed that the control uncontaminated soil samples recorded high bacteria count (6.9 x106 cfu/g). The available soil nitrogen(9.0), soil nutrients nitrate (15.10) and phosphorous (17.3) all recorded appropriate values when compared with WHO standard. The acidity of the soil using pH value as an indicator showed that the uncontaminated control soil samples were acceptable for crops also the Ec values. The heavy metals analysed indicates that the control soil samples were also moderate in heavy metals accumulation when compared with the contaminated soil samples particularly Cd, Pb (0.08) and Hg (0.01) while Cd was not detectable. These findings have shown that automobile activities can denature soil properties which could lead to soil infertility. The automobile activities has to be controled by the concerned agencies in Nigeria. Environmental education should be encouraged to reduce effects of anthropogenic activities on soil quality in the study area.

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Soil a vital non-renewable natural resource is an active living system that performs major environmental functions via diverse micro and macro fauna and flora (Sultan *et al.,* 2015). It has nowadays been inaudated with contaminants accrued from industrial processes, economic activities (exploration, mining), agriculture and transportation (Jiang *et al.,* 2013; Navarro *et al.,* 2008; Syed *et al.,* 2012; David and Sunday, 2012). Despite the fact that soil is a limited resource under pressure from climate change, population growth, urban development, wastes disposal, pollution, and demands for affordable food. (Howard, 2019). It holds 3 times as much carbon as the atmosphere, it reduces the risk of flooding via water absorption, habitat to wildlife and yields over 95% global food supplies. However, improper disposal of used motor oil on land

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can lead to loss in its quality by minimizing the abundance and variety of microorganisms residence in it. These changes in soil quality leads to degradation that could hinder economic growth and healthy environment (Johnbosco *et al.,* 2020). According to Campbell *et al.,* (2005) soil quality includes its physical, chemical, and biological properties that depend on soil nutrient pools and reserves. These soil qualities are modulated by land use, factors such as waste management and disposal, affrostation, natural and artificial drainage management ercetera. Used oil is less viscous than unused oil an attribute that enhances its mobility such that when disposed of onto the soil, it adsorbs to the soil particles, reduces porosity and soil aeration. Clogging of soil pores affects its holistic qualities of physical, chemical and biological constituents (Mocek *et al.,* 2012). A great number of noxious and toxic chemical compounds are released into water, air and soil environment that originates mostly from automobile workshops services, industrial and agricultural activities. Many of these toxicants have ecological implications and effects (Adesuyi *et al.,* 2018a; Njoku *et al.,* 2018). Petroleum-related activities have induced concerns about the adverse effects of contaminants from petroleum products on global environment. Petroleum being hydrocarbons are of environmental interest because of toxicity to human, plants and animal resources (Jolaoso *et al.,* 2019). These hydrocarbons pervade the environment beyond the vicinities of petroleum exploration and production activities via storage, transport, discharge and other handling activities during which environment is contaminated (Chukwujindu *et al.,* 2008). Wastes from automobile workshop services are categorized as either maintenance or materials handling wastes (Alabi *et al.,* 2013), these include used heated transfer fluids, spent oil and lubricants, used parts, asbestos from brake pads and solvent wastes used for cleaning, heavy metals among others. Soil contamination associated with heavy metals is a major environmental problem due to potential health and ecological risk associated with metal contamination. Heavy metals are one of the most serious pollutants in natural environment due to its toxicity, persistence, non-biodegradable, bioaccumulation and biomagnification properties with other negative effects it has on soil quality, biota and ecosystem at large (Ekeocha *et al.,* 2017). Metals generally are a natural component of the earth crust which cannot be degraded nor destroyed completely, hence, efforts are geared towards avoiding increase in its presence on soil matrix through anthropogenic activities such as engine wear and tear.

Automobile workshop activities in Nnewi North local council area is a growth pole that has led to establishment of industries in the council area. Nnewi town sudenly has become a center for commerce and industry that harbours one of the largest automobile spare parts markets in West Africa (Ezekeke *et al.,* 2017), this has propelled fast development of the local economy. At Nnewi, automobile workshops operators carry out repair work with oil, grease, petrol, battery electrolyte, paints and other materials that contain deleterious heavy metals which inevitably gets spilled during operation. Automoble waste oil usually contains additives such as amines, phenols, benzene, mixtures of other chemicals including chlorinated biphenyls, chlorodibenzofurans, additives, decomposition products and heavy metals (Omoregbee *et al.,* 2015); Anweting *et al.,* 2024). The improper disposal of such accrued wastes results to soil contamination with attendant increase in pollution incidents in the environment (Singh and Kalamahad, 2011). Pollution arising from improper disposal of used engine oil is more widespread than crude oil pollution due to its low viscosity, this is one of the environmental challenges in Nigeria that calls for urgent attention (Udousoro, Umoren and Asuquo, 2011). Most of activities carried out at automobile workshop can lead to soil compaction, erosion and pollution with impacts on soil quality and ecosystem health . Automobile waste generated during repair services are engine oil, grease, hydraulics, petrol, transmission fluid, power steering fluid, brake fluid, antifreeze solvents, degreasers including solid wastes like metals and plastics (Alabi *et al.,* 2013). These are disposed off directly on the floor of the automobile shop. By the improper disposal method, liquid wastes are adsorbed onto the soil while the solid wastes are buried over time. The automobile workshop generated wastes are of high heavy metal constituents capable of contaminating ground water and soil nutrient (Adelekan and Abegunde, 2011). Heavy metals are capable of increasing or decreasing the soil's organic compound, physicochemical and microbial properties. Decay of automobile solid wastes releases metals and other harmful substances into the soil. Bioaccumulation of heavy metals in the soil affects soil quality leading to contamination and pollution of the environment at man's deteriment (Yakubu and Omar, 2019). Thence, objective of this paper was to evalaute the physicochemical parameters, total bacteria count and some heavy metal levels in soil from automobile workshop activities at Nnewi Local Government Area, Anambra State, Nigeria.

## MATERIALS AND METHODS

*Area of Study:* Nnewi North is located within latitude 5º55'0"N 6º5'0"N and longitude. It is one of the major cities in Anambra South Senatorial Zone of Anambra State (Fig. 1). Anambra State is one of 36 states in

Nigeria and one of five states in the south-east geo-political zone of the country. The other states are Abia, Ebonyi, Enugu and Imo. Geographically, Nnewi falls within the tropical rain forest region of Nigeria (Nfor, 2006). Though it suffers from soil leaching and erosion which has reduced the soil in some areas to a porous sandy terrain, it remains an area of rich agricultural produce and the epicentre of business trade. The city is located east of the Niger River, and about 22 kilometres south east of Onitsha in Anambra State, Nigeria (Nfor, 2006). It is the second largest and second most populous city in the southern part of the country (Ezekeke *et al.,* 2017).

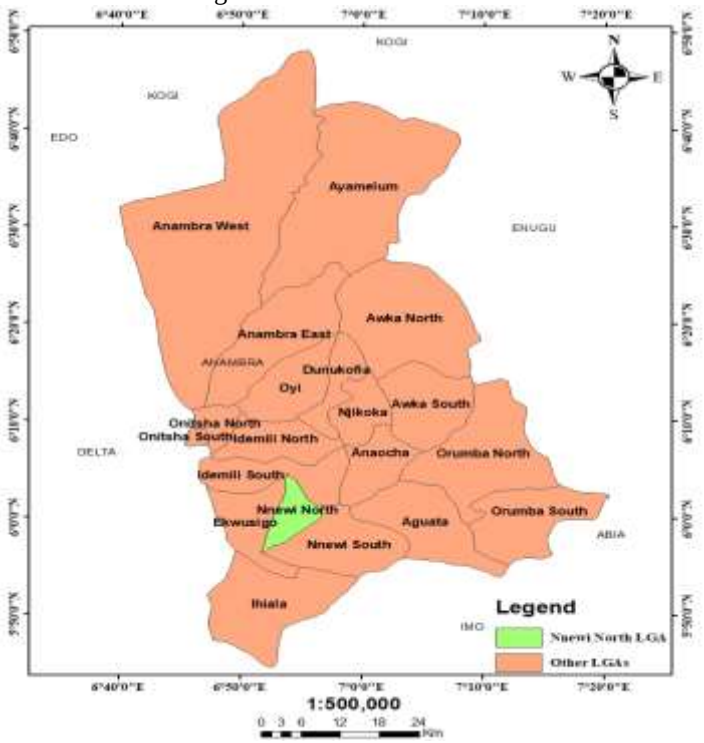


**Fig 1:** Location of Nnewi North LGA in the map of Anambra State
**Source:** Degree Group Limited (2023).

*Research Design:* In this study, field survey and experimentation design were adopted in order to achieve the research aim and objectives. The experimental design focused on soil sampling and sample analysis to determine the effects of spilt engine oil on the soil physical and chemical quality. In terms of the field survey design, a personal observation was applied in collecting information on the quantity of spilt used engine oil, the method of disposing the spilt engine oil and the environmental effect of disposing spilt engine oil on soil.

*Field Observation and Survey:* Field observation was conducted as part of the data collection exercise. A hand-held GPS was used to determine coordinates where soil samples were collected in the study area as shown in Fig. 2. For the field survey, questionnaire was administered to the automobile workshop owners to ascertain awareness level of automobile workshop activities and its effects on soil and environment.

*Soil Sampling and Treatment:* The sampling technique used was random sampling, automobile workshop in the study area were divided into four sections that make up Nnewi north LGA and randomly collected soil samples from each section. The soil samples were collected using an improvised soil auger. The sampling points were labelled AWS 1, AWS 2, AWS 3 and AWS 4. At each of these sampling locations, auger boring instruments were used to bore holes of 0-15cm depth (top soil) and subsoil of 15-30cm depth for the collection. A sample (0-15cm and 15-30cm) was also collected from an agricultural land within the study area which serves as control sample and was coded CONT. These samples were each homogenized in a clean plastic plate and a composite sample was drawn from each. The samples were poured into polytene bags labelled adequately and transported to the laboratory immediately for analysis. A total of ten soil samples were analysed for the study, eight from the automobile workshops and two from the agricultural land use as control (Fig. 2).

*Laboratory Analysis:* Laboratory analysis was carried out on soil samples collected from the study area. The physicochemical parameters analysed includes pH,

Bulk density, Porosity, Soil organic carbon, Soil organic matter, Soil Texture, Conductivity, Nitrate, Phosphorous and Oil and Grease according to Alpha 2005 and USEPA, 2008. The biological parameter determined was the total bacteria count while heavy metals (Mercury, Lead, Cadmium and Arsenic) were analysed using Atomic Absorption Spectrophotometer (Umeoguaju, et al., 2022; USEPA, 2008).

*Determination of Physicochemical Parameters in Soil Sample:* The collected soil samples were air-dried at room temperature for three days, stored in a container (a zip lock bag), labeled and taken to a laboratory for analysis using standard method according to American Public Health Association, APHA, 1999 methods of analyses and USEPA, 2008) .

*Estimation of Bacterial Counts in Soil Sample:* The soil samples were refrigerated at 6 °C for 2 days before taken to the laboratory. At the laboratory, standard plate count that estimates the population density of bacteria in a sample by plating a small and dilute portion of the sample and counting the number of bacteria colonies was used. In the plate count the sample was diluted in a series of step (1:10) and these dilutions were plated onto agar dishes. That is a soil sample was serially diluted in water, and then dispersed onto agar growth plates. The resulting colonies were then counted and recorded.

*Heavy metals determination:* For heavy metal anysis done with AAS, the soil sample was digested with mixture of HNO3/H2SO4 under fumehood at 600ºC for 6 hrs, the resulting carbonaceous residues (ashes) was then dissolved in dilute acid solution for aspiration in Atomic Absorption spectroscopy according to Umeoguaju, et al., 2022; USEPA, 2008.

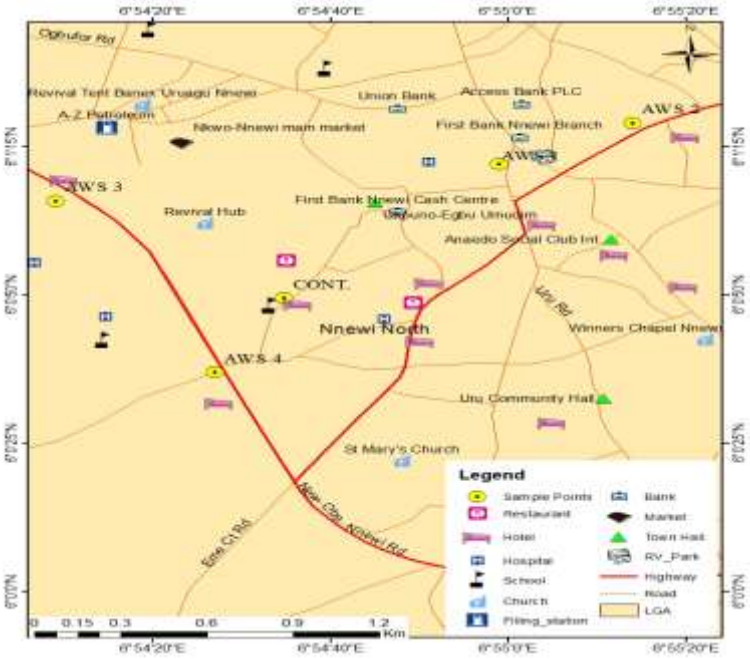


**Fig 2:**Map of Nnewi North LGA showing the Soil Sample Location**.**

*Statistical Methods of data Analyses:* The obtained data were plotted with the aid of Microsoft excel software and IBM SPSS Statistical software to show the pictorial relationship between physicochemical and biological parameters. Generated data were statistically analysed using general descriptive statistics such as mean, mode, range, standard mean error, standard deviation, variance and coefficient of variance. Correlation coefficient was used to compare the relationship between the physio-chemical and biological variables across the analyzed auto mechanic workshop soil samples. One-way Analysis of Variance (ANOVA) at significant level of 0.05 was used to test the research hypothesis.

## RESULTS AND DISCUSSION

The study revealed from field survey that automobile workshop operators at the study area do not have adequate structures, hence perform activities on bare soil which undermines the environment. Also, it was not only observed that automobile technicians do not possesse waste oil storing facility rather dispose the waste engine oil on ground leading to blackish soil textures of the workshops immediate vicinity due to long-term disposal of spent oil on the ground. The questionnaire survey carried out among the owners of the automobile workshops depicts that all respondents

were male. The ages ranges as follows: 25% were 20-29, 25% were 30-39 and 50% were 40-49 age brackets respectively. More so it was discovered that 25% of respondents have been in automobile workshop business for 3-5 years while 75% have been in business for more than 5 years an indication of number of years the soil has been exposed to such degradative activites. The physicochemical properties of the soil samples drawn from four automobile workshops and a control sample from the study area is presented in Table 1. The tested parameters includes: pH, Conductivity, Bulk density, Porosity, Phosphorous, Nitrate, Total organic carbon, Percentage clay, organic matter, Soil texture, % silt, % sand, and Oil & grease. It is shown from the Table, that concentrations of most soil physicochemical properties are higher in control soil samples than the automobile workshops soil samples. However, using the One-way Analysis of Variance (ANOVA) calculated P-value (**0.00000006)** was less than the significant level of 0.05 which implies that there is a significant difference across the physiochemical properties of the automobile workshop soil and the control soil samples. Also the variations across all physicochemical properties of the control soil samples and the automobile workshop soil samples indicates healthier control soil sample than automobile soil samples. This is an indication that automobile activities affects soil quality. The values of soil nutrient properties such as nitrate, phosphorus, soil organic carbon were also higher in control soil sample, again it depicts healthier soil for agricultural purposes than the soil from automobile workshop vicinities. This is similar to Echiegu *et al* (2022) whose work on effect of spent engine oil on soil properties conluded that spent engine oil contaminats agricultural soil by laden it with heavy metals as well as clog soil pores leading to poor soil aeration. Also Jolaoso *et al* (2019) assertted in their work on impact of used motor oil on soil qualities that used motor oil hinders soil fertility via pore clogging that results to poor aeration. However, the higher oil and grease found in AWS 3 soil smple corrabolates Horsfall, 2001 findings on complex mixture of hydrocarbon that consititutes environmental pollution especially when oil spills on large scale. Uruagu is the oldest quarter in Nnewi with highest developmental stride by default.

**Table 1:** Mean values of physicochemical parameters of soil samples

| **Parameters** | **AWS 1** | **AWS 2** | **AWS 3** | **AWS 4** | **CONT.** |
|---|---|---|---|---|---|
| pH | 6.17 | 6.25 | 6.185 | 6.375 | 6.785 |
| Bulk density g/ml | 1.3 | 1.24 | 1.29 | 1.225 | 1.285 |
| Particle density g/ml | 1.22 | 1.12 | 1.19 | 1.04 | 1.105 |
| Porosity | 0.06 | 0.1041 | 0.09225 | 0.1324 | 0.13575 |
| Soil organic carbon % | 12.845 | 11.839 | 9.845 | 10.728 | 16.339 |
| % sand | 55.88 | 61.575 | 55.89 | 62.8195 | 51.939 |
| % Silt | 22.47 | 26.35 | 26.225 | 22.544 | 23.339 |
| % clay | 21.65 | 12.075 | 17.885 | 14.6365 | 24.722 |
| Phosphorus ppm | 10.8395 | 8.8545 | 11.0605 | 8.4995 | 17.343 |
| Soil organic matter | 3.37 | 5.388 | 4.6715 | 4.327 | 6.566 |
| Conductivity usm/cm | 152.78 | 167.7845 | 163.075 | 183.165 | 223.395 |
| Oil and grease % | 0.785 | 0.93 | 1.47 | 1.1595 | 0.245 |
| Nitrogen mg/l | 5.39 | 4.425 | 5.0655 | 4.1545 | 9.0325 |
| Nitrate mg/l | 11.787 | 13.788 | 13.5655 | 7.165 | 15.0655 |

*N/B: AWS 1 = Uruagu; AWS 2 = Nnewichi; AWS 3 = Otolo; AWS 4 = Umudim & CONT. = Control (Agricultural Farmland).*

The biological property of the soil samples is shown on Table 2. The analysed parameter was total bacteria count. It depicted from the table that the control soil sample had the highest concentration of the total bacteria count. In addition, from One-way Analysis of Variance (ANOVA) the P-value (**0.49019)** was greater than the significant level at 0.05. This implies that though the biological properties of the automobile workshop and control soil samples showed variations across the samples, there is no significant difference between the tested biological property of the automobile soil samples and the control.

The high concentrantration of total bacteria count exhibited by the control soil sample is similar to Akpoduado, *et al* (2022) studies that asserted that the detrimental effects of automechanic activities were on humans and the effects disrupts growth and flowering of arable plants. Total bacteria counts number less than 10 6 per gram indicates poor soil health, which may be due to lack of nutrients as found in low organic metrics soils as a result to abiotic stress imposed by extreme microenvironment condition **(**Adewale and Uchegbu, 2010)).

**Table 2:** Mean values of Biological Parameter of the soil samples

| Parameters | AWS 1 | AWS 2 | AWS 3 | AWS 4 | CONT | **WHO STD.** |
|---|---|---|---|---|---|---|
| Total bacteria count (x106 cfu/g) | 2.75 | 2.8 | 6.05 | 5.15 | 6.9 | 1 x $10^9$ to 1 x $10^{11}$ bacteria per gram |

The analysed heavy metals in the study were Arsenic, Mercury, Lead and Cadmium (Table 3). From the table it is shown that all the automobile workshop soil samples had higher values than the control soil sample. The One-way Analysis of Variance (ANOVA) showed that the P-value (**0.000096)** was less than the significant level at 0.05. An indication that there is a significant difference between the concentration of heavy metals across the automobile soil samples and the control soil sample. Hence, there is presence of heavy metals in the automobile workshop soil samples which is as a result of direct disposal and accumulation of spent engine oil unto the bare soil. This findings corroborrates the work done by Ogunkolu *et al* (2019) who stated that the mechanic workshop soils represent potential sources of heavy metal pollution to the environment.

**Table 3:** Mean Values of some Heavy Metals of soil samples

| Parameters (ppm) | AWS 1 | AWS 2 | AWS 3 | AWS 4 | CONT. | WHO STD. |
|---|---|---|---|---|---|---|
| Arsenic | 0.02 | 0.01 | 0.05 | 0.02 | 0.01 | 0.0 |
| Mercury | 0.05 | 0.18 | 0.06 | 0.04 | 0.01 | 0.0 |
| Lead | 0.36 | 0.47 | 0.38 | 0.42 | 0.08 | 2.0 |
| Cadmium | 0.02 | 0.01 | 0.04 | 0.16 | 0.00 | 0.02 |

*Source: WHO (1996).*

It shows from table 3 that AWS 3 had the highest concentration of Arsenic with a value of 0.05ppm while the control had the lowest concentration value (0.01ppm). For Mercury and Lead, AWS 2 had the highest concentration values of 0.18ppm and 0.47ppm, the control sample had the lowest concentration values of 0.01ppm and 0.08ppm respectively. In addition, AWS 4 soil recorded the highest concentration of cadmium (0.16ppm) while Cadmium was absent in the control soil sample. This is another indication of soil quality contamination via automoblie workshop activities particularly during services such as engine vehicle, transmission system, battery charging, fuel tank and clutch repairs among others. These repair services release waste engine oil, transmision fluid, hydraulic oil among others all of which are disposed off on bare soil. The increase in heavy metals concentration in ecosystems in Nigeria has been attributed to increase in auto mechanic activities (Adewale and Uchegbu, 2010: Echiegu et al., 2022). Also Campbell *et al.*, (2005) asserted that motor servicing centres also known as mechanic workshops are sources of automobile waste laden with metals in many urban areas. The One-way Analysis of Variance (ANOVA) conducted at significant level of 0.05 to test the research hypothesis using the mean values of the four automobile workshop soil samples is shown on Table 4. The results indicate that the null hypothesis Ho which states that there is no significant environmental effect of automobile workshop activities on soil quality in the study area can be rejected. Therefore, the alternative hypothesis Hi which stated that there is a significant difference between the concentration of soil properties of the automobile workshop soil and the control soil samples in the study area is accepted. In addition to the laboratory result, field survey revealed that the operators (respondents) attested to disposing generated waste (spent engine oil) unto the bare soil.

**Table 4:** Analysis of variance (ANOVA) of soil samples across soil parameters.

| Groups | Count | Sum | Average | Variance |
|---|---|---|---|---|
| pH | 5 | 31.765 | 6.353 | 0.064858 |
| Bulk density g/ml | 5 | 6.34 | 1.268 | 0.001108 |
| Particle density g/ml | 5 | 5.675 | 1.135 | 0.0051 |
| Porosity | 5 | 0.5245 | 0.1049 | 0.000971 |
| Soil organic carbon % | 5 | 61.596 | 12.3192 | 6.329858 |
| % Sand | 5 | 288.1035 | 57.6207 | 20.2477 |
| % Silt | 5 | 120.928 | 24.1856 | 3.799661 |
| % Clay | 5 | 90.9685 | 18.1937 | 26.18804 |
| Phosphorus ppm | 5 | 56.597 | 11.3194 | 12.65216 |
| Soil organic matter | 5 | 24.3225 | 4.8645 | 1.43221 |
| Conductivity usm/cm | 5 | 890.1995 | 178.0399 | 762.6339 |
| Oil and grease % | 5 | 4.5895 | 0.9179 | 0.208447 |
| Nitrate ppm | 5 | 61.371 | 12.2742 | 9.522923 |
| Available nitrogen mg/l | 5 | 28.0675 | 5.6135 | 3.895258 |
| Total bacteria count x106 cfu/g | 5 | 23.65 | 4.73 | 3.56825 |
| Arsenic ppm | 5 | 0.099 | 0.0198 | 0.000328 |
| Mercury ppm | 5 | 0.353 | 0.0706 | 0.004222 |
| Lead ppm | 5 | 1.7048 | 0.34096 | 0.023198 |
| Cadmium ppm | 5 | 0.2305 | 0.0461 | 0.003996 |

*Conclusion:* In conclusion, this paper has successfully evaluated some critical physicochemical parameters,bacterial counts and selected heavy metals such as mercury, lead, cadmium and arsenic levels in soil samples collected from automobile workshop activities in Nnewi Local Government Area of Anambra State, Nigeria. Data obtained reveals significant higher levels of the samples when compared to WHO standard levels.

*Declaration of Conflict of Interest:* The authors declare no conflict of interest

*Data Availability Statement:* Data are available upon request from the corresponding author.

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