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Assessment and Source Apportionment of Heavy - Metals (Zn, Pb, Cu, Ni, Cd) on Street Dust of Oshodi-Isolo Area, Lagos State, Southwestern Nigeria

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ABSTRACT

This research reports the results of heavy metals content of Street dust in Oshodi-Isolo Area of Lagos state. The dust samples were collected randomly once a week August - December, 2022 at ten different locations in Osho -Isolo Area. Samples were obtained by sweeping surface dust into plastic waste packer using plastic brush and transferred into pre-labeled polythene bags. Samples collected at each location were filtered through 75 µm stainless steel sieve, weighed and digested with appropriate amount of HNO3 and H2O for 2 hours.The concentrations of heavy metals were analyzed using Atomic Absorption Spectrophotometer (AAS) PG - 990. Results of the analysis showed that the percentage contribution of each heavy metals at Oshodi - Isolo Area were Zn - 51.52 %, Pb - 36.78 %, Cu- 8.65 %, Ni - 2.79 % and Cd - 0.25 %. The most abundant pollutant heavy metals were Zn-1445.43 mg/kg while the least was Cd - 6.99 mg/kg. The most polluted site is Agege - motor road (AGM)-1372.11 mg/kg while the least polluted site is Adewumi Ogefon (ADO)-15.41 mg/kg with percentage contributions 48.91 % and 0.55 % respectively. The sequence and distribution follow the pattern thus: Zn > Pb > Cu > Ni >Cd. The Principal Component Analysis PCA showed that the major sources of heavy metals in Oshodi- Isolo dust are mainly anthropogenic and two factors PC1 and PC2 accounted for 79.855% of the total variance. Each of these factors were identified as sources of heavy metals in dust of Oshodi - Isolo area with Traffic/ Vehicular emission dominating. Pearson's significant correlation analysis revealed that there is a strong positive correlation amongst the heavy metals at 0.01 levels of significant. The concentration of Heavy metals obtained exceeded the recommended limits of the Federal Ministry of Environment (FME), European communities (EC) and United Nations Environmental Programme (UNEP) permissible level for heavy metals in the dust suggesting that the study area is polluted.

Keywords: Dust, Environment, Heavy-Metals, Atomic Absorption Spectrophotometer Concentration.

1.0. Introduction

Increase in urbanization and industrialization have resulted in increased levels of dust contamination,raising serious environmental concerns (Hu *et al.*, 2020). Dusts are fine solid particles in the atmosphere from various sources such as soil, dust lifted by wind and pollutions. They may be described as fine solid particles that are existed in the environments through diverse processes and can accumulate outdoor, especially on cemented roads and hard pavement (Lu *et al.*, 2014; Rahman *et al.* 2019). It acts as the sink and source of toxic metals to its corresponding environment especially soil and air (Men *et al.*, 2020). Street dust is accounted as hazardous materials due to its high transportability into environmental mediums and poses a potential threat to public health (Khademi *et al.*, 2019; Yesilkanat and Kobya, 2021). Street dust is one of the useful indicator of environmental quality in urban area, which could be used to assess heavy metals and other pollutants in the environment (Amato *et al.*, 2009, Lu *et al.*, 2010). Direct inhalation of fine dust by people traversing the streets and those residing in the vicinity could be by ingestion through hand - to - mouth, eating poorly washed fruits and vegetables and dermal exposure are the routes of human exposure to road dust (Lorenzo *et al*., 2011). The chemical contents of street dust and airborne particulates are similar (Liu *et al*., 2007). Vehicle exhaust, tire dust, spillages and leaks from vehicles, road surface erosion material and vegetative plant fragments, garden soil and litter are the sources of deposited surface Street side dust (Mostafa *et al*., 2009).

The term heavy metal may refer to any metallic substance with relatively high density and such a substance is toxic at low concentrations. Although, heavy metals are naturally occurring elements that are found in the earth's crust, most environmental contamination and domestic and agricultural use of metals and metal-containing compounds (Herawati *et al.,* 2000 and He *et al.,*2005). Examples of heavy metal include Zinc (Zn), Nickel (Ni), Copper (Cu), Mercury (Hg), Cadmium (Cd) , Chromium (Cr), Thallium (Tl) and Lead (Pb**).** Heavy metals are group of non - biodegradable pollutants. They are not readily detoxified and removed by metabolic activities once they are available in the environment. This may subsequently lead to their buildup to toxic levels or bioaccumulation in the ecosystem (Lawal *et al.*, 2011). Heavy metals are dangerous because they tend to bio-accumulate (Bawuro *et al.,* 2018). Heavy metals can thus penetrate into the human body and pose a great threat to human (Aeolian *et al.,* 2008; Lu *et al.*, 2010). The heavy metal contamination such as Cr, Ni, Cu, Pb, Zn, and Cd are high in Street dust in developed and industrial cities, and the pollution level of heavy metals in Street dust is much higher than that in urban soil (Wei *et al.*, 2010). The five metals to be addressed in this study (Zn, Pb, Ni, Cu and Cd) are among the most often found heavy metals in the atmosphere including dust and to a large extent are harmful to human beings and the entire ecosystems. For instance, Consumption of excessive amounts of Zinc might results in pancreatic problems, anemia, and muscle soreness (Roney *et al.*, 2006). Studies on atmospheric dust fall reported that Zn likely comes from the combustion of engines, fossil fuels, tire wear, vehicular emissions (Valotto *et al.,* 2015; Valotto, Cattaruzza and Bardelli, 2017; Hwang *et al.,* 2016 ; Kui Cai and Chang Li, 2019). Pb in the road dust might accumulate from traffic emission, industrial activity and as pollution from the use of arsenical pesticides, herbicides, crop desiccants and metal smelting (Bhuiyan *et al.,* 2015; Men *et al.,* 2018; Xiao *et al.,* 2020 ; Rahman *et al.,* 2019). Cu is regarded as a tracer for non-exhaust vehicle emission (Cui *et al.*, 2019; Rai *et al.*, 2021), Cu is used in lubricants to improve friction stability and emits during brake abrasion (Querol *et al.,* 2007; Amato *et al.*, 2014). Sources of Cu also include non - ferrous metallurgical industry, metal processing and refinery industry (Ramírez *et al.*, 2018; Men *et al.*, 2018). High levels of copper exposure can impair the immune system, induce liver, renal, and gastrointestinal problems, as well as Wilson's syndrome and anxiousness (Taylor *et al.*, 2020; Briffa *et al.*, 2020). Exposure to excessive amounts of Cd has been linked to renal disease, infertility, mental and digestive issues, and cancer (Faroon *et al.*, 2012). A number of health problems are associated with prolonged exposure to cadmium particularly in children, including neurologic problems, kidney problems, high blood pressure, heart disease, and reproductive system problems (Abadin *et al.*, 2007). The major sources of Cd in road dust might be lubricating oil, diesel fuel, tire, and brake wear, batteries, plastic and building materials (Foti *et al.*, 2017; Men *et al.,* 2020; Heidari *et al.,* 2021; Wei *et al.*, 2010). Human exposure to Nickel, are more likely to suffer from respiratory problems, cardiovascular disease and cancer (Buxton *et al.,* 2019).

Although, there are enormous studies on the levels of Heavy metals on Street dust in the world (Kui, Cai and Chang, Li (2019); Xu *et al.*, 2021; Abassi *et al.*, 2020; Kara *et al.*, 2020; Li *et al.*, 2020; Ahmad *et al.*, 2015) but currently there are little or no literature on Heavy metals on Street dust in Lagos State, particularly in Oshodi - Isolo Area(Table 1).The choice of Oshodi - Isolo as the study area is due to its high vehicular, human and industrial activities. Therefore, the main objectives of the present study were to : (1) assess and evaluate the levels of Heavy metals on Street dust of Oshodi - Isolo Area (Figure 1). (2) determine the Sources of heavy metals in the study area. (3). determine the percentage contributions of each Heavy metals to pollution in Oshodi - Isolo Area.

2.0. Methodology

2.1. Study Area

The study was conducted in the following areas of Oshodi - Isolo (N6^0.56777 and E3^0.34231 - N6^0.5162 and E3^0.37369) area of Lagos state which include Shopeju street (SPS), Adewumi Ogefon (ADO), Aswani road (AWR), Osolo way (OSW), Agege -motor road (AGM), Church street (CHS), Oshodi road (OSR), Ariyibi oke (ARS), Brown street (BRS) and Apapa - Oshodi express way (APE) and the control site, Botanical garden Yaba College of Technology (BG) (Figure 1).

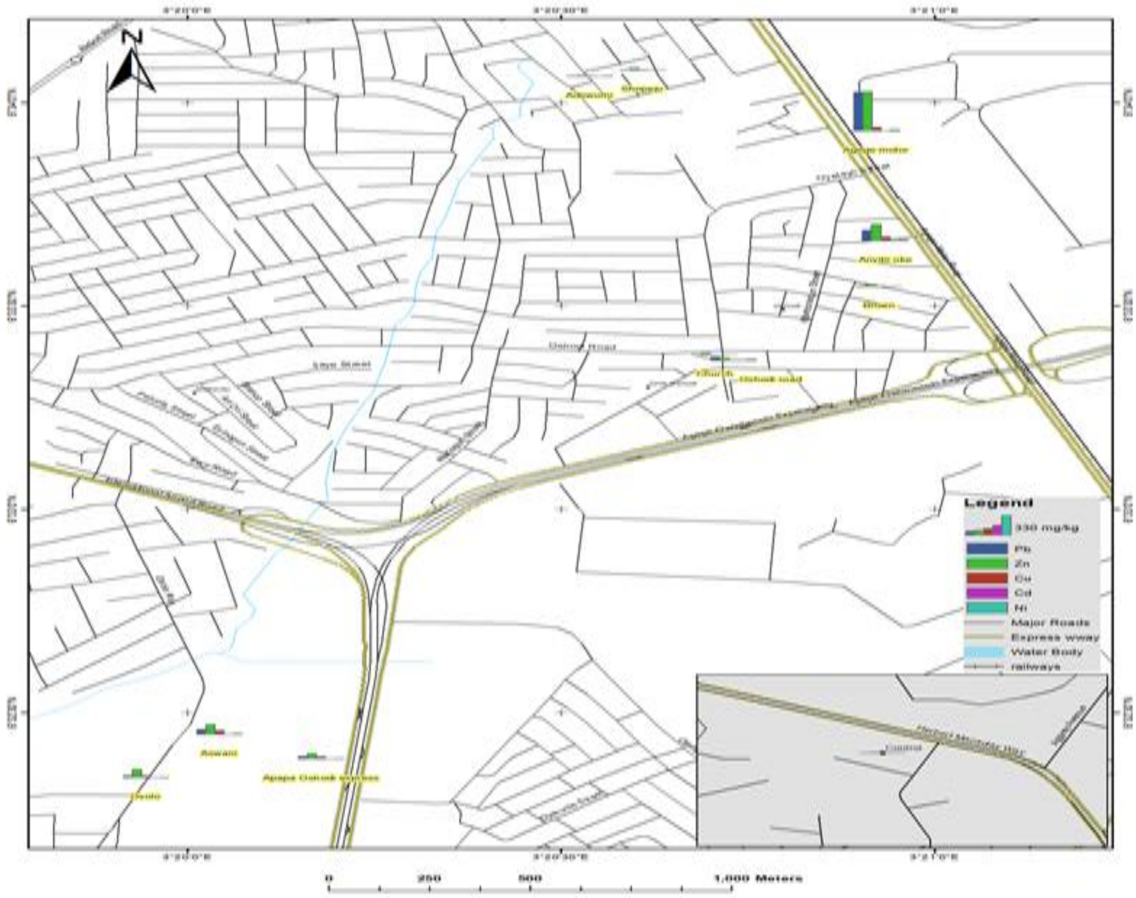

Figure 1: GPS Map of Oshodi - Isolo showing average mean concentration of Heavy metals.

2.2 Selection of Sampling Sites

The eleven sites including the control were carefully chosen based on accessibility, availability of open spaces and of course area with maximum influence from anthropogenic activities such as vehicular traffic density, human activities as well as industrial activities(Table 1). The geo-referencing was carried out by using GPS MAP 76S (Garmin).

Table 1 : Sampling sites, Characteristics and their Coordinates

Location/ Sites	**Code**	**Latitude**	**Longitude**	**Site Description**
Oshodi road	OSR	N6^0.55609	E3^0.33451	This is a major road with high vehicular and traffic emissions. Few garages with lots of abandoned vehicles.
Church street	CHS	N6^0.55609	E3^0.3451	It is a commercial area with high traffiction, filling stations and vulcanizing activities.
Brown street	BRS	N6^0.55912	E3^0.34877	This is a commercial area where traders from different ethnic groups sell foodstuffs and non - edibles like wears, electrical/electronic materials.
Shopeju	SPS	N6^0.5680	E3^0.3435E	It is a residential area with little vehicular emissions, traffic congestion with fumes from generators.
Adewumi Ogefon	ADO	N6^0.56774	E3^0.34231	Residential area with no traffic congestion, generator fumes from residents and shops.
Agege motor road	AGM	N6^0.5655	E3^0.3487	It is a major road with traffic congestion and emissions from vehicles. Filling stations and vulcanizing activities in the area.

Ariyibi oke	ARS	N6^0.5610	E3^0.3489	It is a commercial area with few residents, high traffic congestion especially due to the activities of buyers and sellers.Vehicular emissions and mechanic workshops.
Osolo Way	OSW	N6^0.539	E3^0.33241	A site with Nylon and Plastic recycling industries, abandoned cars, market and panel beater workshops
Aswani road	ASR	N6^0.54077	E3^0.33405	An industrial area with industry such as Emzor Pharmaceuticals, there is traffic congestion, spillage of petrol and diesel.
Apapa oshodi express	APE	N6^0.53986	E3^0.33691	A site with industries such as Chellarams, Nylon companies, vehicle emissions, due to vehicular activities.
YCT Botanical garden (control)	BG (CTL)	N6^0.51626	E3^0.37369	There is little or no Anthropogenic activity.A site where different agricultural crops are grown.

2.3 Sample Collection

Dust samples were collected from eleven sites within the study area, at least 100m apart once a week from August - December, 2022. Samples were collected in the morning while the dust has settled well throughout the night and before heavy morning traffic movement that can disrupt the dust. The samples were randomly collected from both sides of the road by sweeping surface dust into plastic waste packers using plastic brush and transferred into pre- labeled polythene bag(Shabbaj *et al.,* 2018; Aguilera *et al.,* 2019; Praveena *et al.,* 2019). All irrelevant materials such as cigarette ends, papers, plastics etc. were carefully hand- picked. Thereafter, samples collected at each location were filtered through 75 µm stainless steel sieve. The samples were then taken to the laboratory for further treatment and analysis.

2.4 Digestion of dust Samples for Heavy metals

2.0g of sieved dust was weighed using an analytical balance and transferred into a conical flask for digestion. 30ml nitric acid and 10ml concentrated hydrochloric acid prepared in the ratio 3:1 was added. The solution was mixed thoroughly and heated on magnetic heated stirrer, then refluxed at 90ºc for 20 minutes. After the disappearance of brown fumes, the digested solution was cooled and then filtered through Whatman type 589/2 filter paper. The filtrate was diluted to 50 cm^3 with de-ionized water . The metal contents in the filtrate were determined using an atomic absorption spectrophotometer (AAS) PG - 990. (Men *et al.,* 2019; Benhaddya *et al.,* 2016).

2.5 Statistical analysis

The analysis of variance (ANOVA) together with mean and standard deviation of each heavy metals were carried out on the data obtained from the street dust(Table 3). Kaiser-Meyer - Olkin and Battlet's test were also carried out to confirm the sampling adequacy (Table 2).

Table 2 : KMO and Battlet's test

		Heavy metals
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.867
Bartlett's Test of Sphericity	Approx. Chi-Square	2769.207
	Df	55
	Sig.	0.000

3.0. Results and Discussion

3.1 Heavy metals distribution in Oshodi - Isolo dust.

The results of this research showed that the main contributors to the dust pollution in Oshodi- Isolo area are Zn - 51.52 %, Pb -36.78 %, Cu- 8.65 % and to a lesser extent Ni - 2.79% and Cd- 0.25 % (Figure 2). The most abundant Heavy metal in the dust of Oshodi- Isolo is Zn 1445.43 mg/kg followed by lead while Cd 6.99 mg/kg is the least abundant (Table 4). The high presence of Zn may be due to emission of Zinc originating from wearing of brake lining; losses of oil and cooling liquid, corrosion of galvanized steel safety fence, wearing of tyres etc; while Nickel could be due to the combustion of fossil fuels, smelting of metals/steel and oil activities. Lead levels be could be attributed to emissions from vehicles which use leaded gasoline and to exhaust gas coming from fuel and from worn metal alloys which might have accumulated over times owing to its long residence time in the environment. (Figure 2). The highest concentration of Zinc was recorded at Agege motor road - 651.04 mg/kg while the least concentration was recorded at Adewumi Ogefun- 12.11 mg/kg. The highest concentration of lead was also recorded at Agege motor road - 641.63 mg/kg whereas the least concentration was recorded at Church Street - 1.94 mg/kg (Table 4). The high presence of lead at Agege motor road may be due to the high commercial, automobile and vehicular activities in the area, spillage of petroleum products, smoking of cigarettes, paint chips from the walls of industrial buildings, careless discard of lead acid batteries used in automotives as well as the use of industrial grade and non - domestic paints by the surrounding industries.(Table 1). The level of Lead at Agege motor road were significantly different ($p < 0.05$) from all other sites. The highest concentration of copper -57.99 mg/kg and nickel- 22.12 mg/kg was recorded in Aswani road and Agege motor road respectively. Adewumi Ogefun has the least concentrations of Copper -0.98 mg/kg and Nickel- 0.43 mg/kg. The presence of Copper may be due to the manufacturing of electrical cables, mining of metal, production of cans and the use of pesticides, combustion of fossil fuels, smelting of metals, vehicular emission, traffic congestion and industrial processes that uses these metals or their compounds. (Table 4). There is significant difference in the level of heavy metals in the study area ($P_v < 0.05$) (Table 3). The sequence and pattern of distribution of Heavy metals content of Oshodi - Isolo dust is as follows: Zn > Pb > Cu > Ni > Cd with the mean concentration of - 131.40, 93.79, 22.07, 7.11 and 0.48 mg/kg respectively (Table 4). The most polluted site is Agege motor road -1372.11mg/kg while the least polluted site is Adewumi Ogefun- 15.41 mg/kg. This could be as a result of both vehicular, human, commmercial and Industrial activities in the area. The trend and percentage contribution of each site to pollution of Oshodi - Isolo dust is as follows: AGM - 48.91 % > ARS-18.84 % > ASR- 11.10 % > OSW- 6.52 % > APE- 5.86 % > OSR - 4.34 % > BRS-1.53 % > SPS- 1.28 % > CHS- 1.00 % > ADO- 0.55 % > BG(CTL)-0.17 % (Table 3). The result of this research agrees with the results obtained in other areas of the world and also showed that concentration of heavy metals depends on the nature of activities in the area (Wang *et al.,* 2021; Li *et al.,* 2020; Kui Cai (2019) ; Xu *et al.,* 2020; Kara *et al.,* 2019; Adie *et. al.,* 2014 ; Ekpo *et. al.,* 2012 ; Mohsen *et al.,* 2012; Christoforidis *et al.,* 2009; Lu *et al.,* 2010; Karbassi *et al.,* 2005 ; Ojiodu *et. al.,* 2017; 2018a, 2018b).

Table 3 : Mean and Standard Deviation of Heavy metals at Oshodi - Isolo area of Lagos - State (mg/kg).

Location/ Sites	Pb Mean ± SD	Zn Mean ± SD	Cu Mean ± SD	Cd Mean ± SD	Ni Mean ± SD
SPS	6.46 ± 0.11	26.24 ± 0.11	2.32 ± 0.11	0.075 ± 0.07	0.73 ± 0.11
ADO	2.11± 0.07	12.11 ± 0.12	0.87 ± 0.11	0.003 ± 0.01	0.32 ± 0.12
ASR	79.05± 0.11	162.08 ± 0.06	57.89 ± 0.11	-0.108 ± 0.06	12.25 ±0.21
APE	39.11 ± 0.66	88.00 ± 0.01	32.13 ± 0.12	-0.02 1± 0.10	5.25 ± 0.31
OSW	19.89 ± 0.12	136.75 ± 0.51	24.38 ± 0.67	-0.303 ± 0.07	1.51 ± 0.11
CHS	1.83 ± 0.11	24.69 ± 0.121	1.25±0.12	0.043 ± 0.01	0.03 ± 0.01
AGM	641.52 ± 0.12	651.03 ± 0.01	56.72 ± 0.08	0.79 ± 0.12	22.05 ± 0.06
OSR	57.10 ± 0.10	38.11 ± 0.10	5.12 ± 0.07	2.49 ± 0.01	16.104 ± 0.10
ARS	174.45 ± 0.11	274.77 ± 0.12	58.27 ± 0.12	2.38±0.17	18.69 ±0.04
BRS	9.41 ± 0.17	28.40 ± 0.16	3.25 ± 0.117	0.74 ± 0.045	1.241 ± 0.16
BG(CTL)	0.80 ± 0.16	3.25 ± 0.16	0.57±0.17	0.121±0.156	0.024 ± 0.01
TOTAL	93.79 ± 182.89	131.40 ±185.19	22.07±24.26	0.487 ± 0.97	7.11 ± 8.22

Mean difference is significant at P<0.05

Table 4: Average Mean Concentration of Heavy metals in street dust of Oshodi-Isolo area. (mg/kg).

Sample Location/ Sites	Pb	Zn	Cu	Cd	Ni	Total
SPS	6.46	26.24	2.32	0.08	0.70	35.80
ADO	2.11	12.11	0.87	0.003	0.32	15.41
ASR	79.05	162.08	57.89	-0.11	12.25	311.38
APE	39.11	88.00	32.13	-0.01	5.25	164.51
OSW	19.89	136.75	24.38	-0.30	1.51	182.83
CHS	1.83	24.69	1.25	0.04	0.33	28.14
AGM	641.52	651.03	56.72	0.79	22.05	1372.11
OSR	57.10	38.11	5.12	2.49	16.104	118.92
ARS	174.45	274.77	58.27	2.3	18.69	528.48
BRS	9.41	28.40	3.25	0.74	1.241	43.04
BG(CTL)	0.80	3.25	0.57	0.12	0.024	4.78
Total	1031.73	1445.43	242.77	6.99	78.47	2805.39
Average	103.70	144.543	24.277	0.70	7.85	
Percentage %	36.78	51.52	8.65	0.25	2.79	100

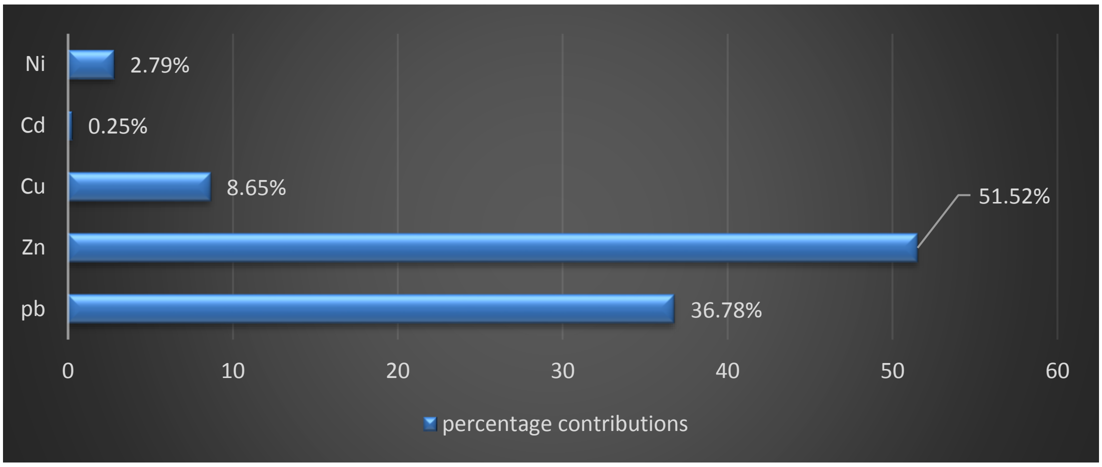

Figure 2: Percentage Contribution of Heavy metals in street dust of Oshodi - Isolo Area

The presence of Nickel in this site may be as a result of fuel combustion from generators as well as frequent bush burning in the surroundings. The highest concentration of cadmium was recorded at Oshodi road- 2.60 mg/kg while the least concentration was recorded at Osolo way - 0.39 mg/kg (Figure 3). The high significant levels of Zn, Pb and Cu obtained in the samples from Oshodi- Isolo is an indication of their concentration in the dust while the low concentration of Cadmium Cd and Nickel Ni suggest low contributing factors to their spread and as well as dust inability to preferentially accumulate these metals (Figure 3).

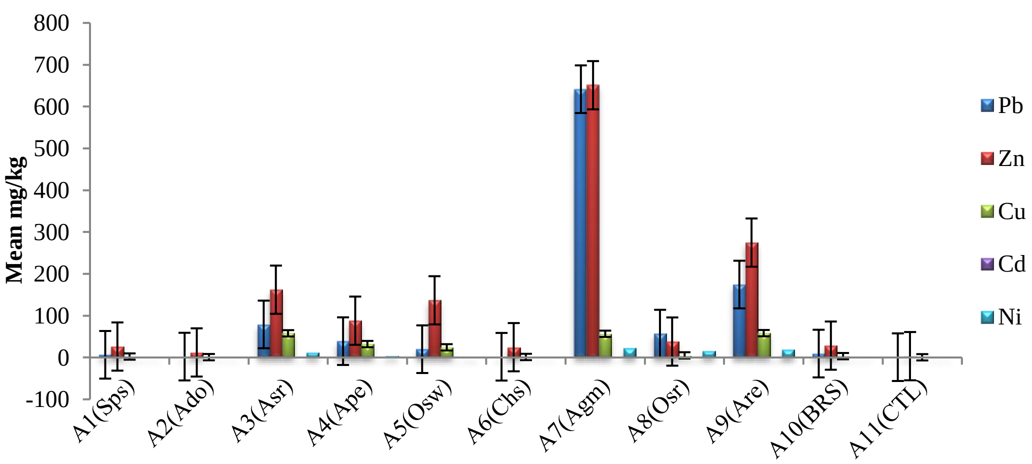

Figure 3 : Average Concentration of Heavy metals in dust of Oshodi - Isolo Area

Though, the concentrations of Heavy metals (Zinc, Lead, Copper, Cadmium and Nickel) in Oshodi - Isolo dust may be high when compared with the values other cities in world (Table 5). This may be due to differences in vehicular and human activities (burning/dumping of waste), environmental management policies and technologies employed, frequency of city street cleaning and local meteorological conditions such as rains, temperature, windspeed which can affect the Heavy metals in the dust (Mohsen *et al.,* 2012). The level of heavy metals in the study area were far greater than the recommended limits of the Federal Ministry of Environment (FME), European Communities (EC) and United Nations Environmental Programme (UNEP) permissible level for heavy metals in the atmosphere (EC, 2006). The concentration of heavy metals in all the sites was higher than the control value . This may be due to the fact that the control environment is an area with little or no anthropogenic activity.

Table 5: Mean concentration of Heavy metals in street dust of Oshodi - Isolo and other selected cities of the world (mg/kg).

CITY	Pb	Zn	Cu	Cd	Ni
Oshodi - Isolo (this study)	1031.73	1445.43	242.77	6.99	78.47
Central China / Arid Desert (Chiana) (Xu *et al.,* 2021)	91.55	222.82	20.00	0.39	-
Shijiazhuang (China) Li *et al.,* 2019	154.78	496.17	91.06	1.86	40.99
Xian(Chiana) Pan *et al.,* 2017	97.4	169.2	46.6	0.72	29.3
Shanghai (Korea) Li *et al.,* 2015	295	735	197	1.23	84
Chengdu(Korea) Li *et al.,* 2015	375	1117	244	4.4	88.1
Guizhou(Korea) Duan *et al.,* 2017	67.81	185.98	129.80	0.62	61.07
Shihwa(Japan) Jeong *et al.,* 2019	612	1824	992	2.22	164
Delhi (India) Suryawanshi *et al.,* 2016	120.7	284.5	191.7	2.64	36.4
(South Africa) Olowoyo *et al.,* 2016	754.3	304.6	157.2	2.54	74.3

3.2. Source Apportionment

3.2.1. Using principal component analysis (PCA) to identify the potential sources of heavy metals in Oshodi - Isolo Area.

The Principal Component Analysis (PCA) are the primary factor analysis techniques that uses eigen values to apportion data sets to identify emission sources depending on the data sets that have been submitted for PCA. It is widely used to reduce large data sets to a few components and here it makes it easier to understand the potential sources of Heavy metals in Oshodi- Isolo dust. It is used to classify variables into groups that can then be associated with factors that contributes to pollutant levels at receptors. The data acquired at Oshodi- Isolo sites were used to conduct PCA analysis. The data for PCA were arranged in a matrix, with the columns representing concentrations of Zn, Pb, Ni, Cu and Cd in dust and the rows representing the sampling locations/ sites. The variance - normalized data matrix were used to identify the predominant components for implicating the potential heavy metals sources. Varimax rotation with Kaiser Normalization was used in the PCA(Table 6). Data were subjected to factor analysis using principal component analysis extraction method and orthogonal Varimax rotation. All KMO values for the individual items (Pv > 0.70) were well above 0.5 and the Kaiser - Meyer Olkin Measure was 0.867 indicating that the data were sufficient for Exploratory Factor Analysis (EFA)(Table 2). The Bartlett's test of Sphericity $\chi^2_{(10)} = 349.080$, $P < 0.05$ showed that there was patterned relationships between the items. The Scree plot confirmed the findings of retaining two (2) factors. Table 6. Showed the factor loadings after rotation using a significant factor criterion of 0.60. Using the Eigen value greater than one rule, two factors were identified. All characteristics with factor loadings of 0.50 and above are retained. Since the goal of factor analysis is to model the interrelationships among items, we focus primarily on the variance and covariance rather than the mean. Two factors were identified as those contributing to the measured values in Oshodi - Isolo area. The PCA analysis classified the dataset of HMs into two principal components (PCs) PC1 and PC2 which accounted for the variances of 79.855% of the total variation in the dataset collected from Oshodi- Isolo area of Lagos state(Table 6). The two principal components are: PC1: This factor 1 accounted for 52.920 % of the total variance in the data. This factor was highly loaded in Pb, Zn, Cu and Ni **.** The source of this heavy metals were from emissions from Traffic / Vehicular and burning of industrial wastes, lubricating oil, diesel fuel, tire, and brake wear (Foti *et al.*, 2017; Men *et al.,* 2020; Heidari *et al.,* 2021). PC1: Factor 1 is attributed to emissions from Traffic / Vehicular, industrial wastes, lubricating oil, diesel fuel, tire and brake wear . PC2: Factor 2 accounted for 26.935 % of the total variance in the data. This factor is loaded with Cd.(Table 6). This heavy metal is released from emissions from Waste dumpsite/ improper disposal of domestic wastes. (Men *et al*,. 2020; Wang *et al*,. 2020; Guo *et al.,* 2021; Mondal and Singh, 2021).

Table 6: The rotated component matrix for data of Heavy metals in street dusts of Oshodi - Isolo **.**

Heavy metals	**Principal components**	
	PC1	PC2
Pb	**0.699**	0.312
Zn	**0.908**	0.104
Cu	**0.856**	-0.073
Cd	-0.007	**0.954**
Ni	**0.801**	0.215
Eigen values	2.646	1.347
% of Variance	52.920	26.935
% of Cumm. Variance	52.920	79.855

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

3.2.2. Correlation coefficient analysis

Pearson's significant correlation analysis were employed to evaluate and statistically link the concentrations of heavy metals with the sources of Street dust.(Table 7). Shows the pearson correlation coefficients, its significance values and the total number of observations. The values of the correlation coefficient range from -1 to 1. The sign of the correlation coefficient indicates the direction of the relationship (positive or negative). The absolute value of the correlation coefficient indicates the strength, with larger absolute values indicating stronger relationships. There is a strong positive correlation amongst the heavy metals in Oshodi - Isolo dust. There is a significant strong positive correlation amongst the heavy metals at 0.01 levels of significant (Enuneku *et al.,* 2017; Kara *et al.*, 2020; Wang *et al*, 2021). This results showed that Pb, Zn, Cu and Ni are likely from common anthropogenic sources such as Traffic /Vehicular, Industrial activities, combustion of fossil fuels, gasoline and diesel exhaust while Cd is likely from common anthropogenic sources : Waste dumpsite/ improper disposal of domestic wastes and sewage. The five heavy metals in Oshodi - Isolo dust were moderately correlated and significant, which indicates that fewer components are required to account for the variation.

Table 7 : Correlation Analysis among the heavy metals in the dust of Oshodi- Isolo (N = 144).

Metals	Pb	Zn	Cu	Cd	Ni
Pb	**1**				
Zn	0.704**	1			
Cu	0.408**	0.700**	1		
Cd	0.465**	0.080	0.052	1	
Ni	0.609**	0.609**	0.572**	0.175*	1
Mean	93.62	179.23	26.35	1.86	8.30
SD	143.35	158.00	21.56	4.90	6.09

**.Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.2.4 Cluster Analysis

The bi-plot suggested that there are two clusters groups for the heavy metals in Oshodi - Isolo dust.(Figure 4). We used hierarchical clustering because the datasets were small and continuous in nature and its' represented by dendrogram.(Figure 5). The two : Cluster 1 Pb , Zn, Cu and Ni and Cluster 2 Pb and Cd. The heavy metals in each cluster are from the same origin or Source : Traffic / Vehicular, Industrial activities, industrial wastes, Waste dumpsite/ improper disposal of domestic wastes and sewage Industrial activities, combustion of fossil fuels, gasoline and diesel exhaust.

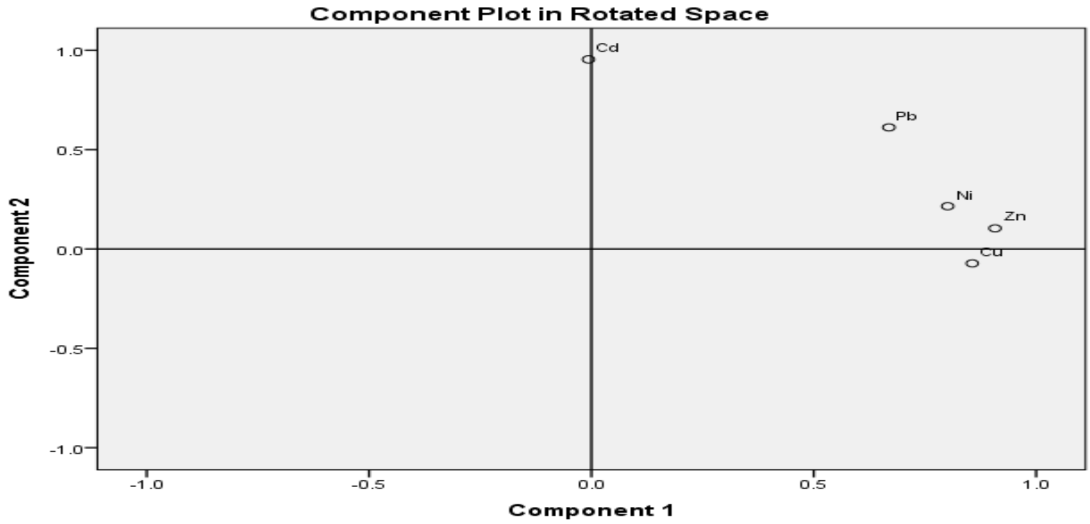

Figure 4: Bi-plot for the heavy metals components

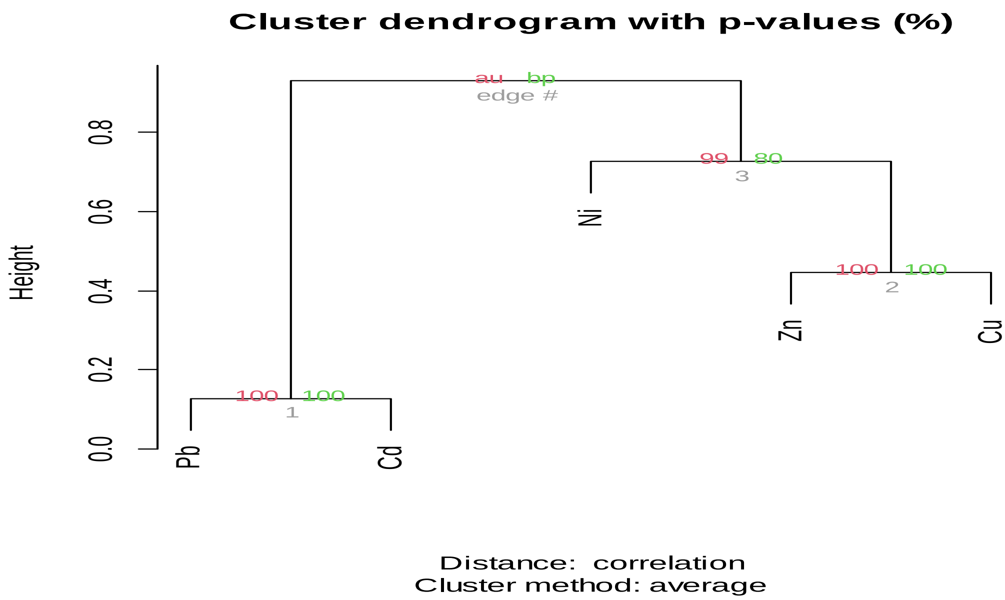

Figure 5: Cluster Dendrogram

4.0. Conclusions

It is evident that the dust of Oshodi - Isolo is highly polluted with heavy metals Zinc Zn-144.54 mg/kg, Lead Pb -103.173 mg/kg, Copper Cu -24.277 mg/kg, Nickel Ni - 7.847 mg/kg and Cadmium Cd - 0.699 mg/kg. The high concentration of these heavy metals could be attributed to anthropogenic activities such as traffic / vehicular emission, industrial activities, industrial wastes, waste dumpsite/ improper disposal of domestic wastes and sewage with vehicular activities dominating. Therefore, there is need for environmental Monitoring, safety and management of Oshodi - Isolo area due to the high concentration of these metal pollution which could be very hazardous to human and plants existence.

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