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Modelling Vehicular Noise Pollution Data in Some Parts of Warri, Delta State Using Multivariate and Confirmatory Factor Analysis

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Abstract

Noise is inevitable. We come across it in our daily lives while driving, working and many routine activities. Many interact daily with machinery, either during working activities, or domestic chores, which produce noise levels large enough to be sources of environmental concern. The focus of the research is to study the issue of noise pollution in some parts of Warri using exploratory and confirmatory factor. In carrying out the noise level measurements, 10 locations comprising of commercial, industrial activities and busy roundabouts were selected. The measurement of sound level was carried out using a type 1 integrated sound level meter accompanied with a Garmin Oregon 650t hand-held GPS. The CR811C noise level meter was held at a height of 1.2m above ground level with the antenna pointing to the sound source. The measurement process was carried out for the 10 locations at two times a day which are: 7.00am – 9.00am and 5.00pm – 7.00pm. The instrument was set at the A-weighting network and the equivalent noise level (Leq) which is the constant noise level that expands the same amount of energy over the same period, was measured for the various locations. Noise measurements was done for ten (10) weeks (70days) between march to May 2021 for each of the 10 locations at mornings and evenings and the weekly average noise level in (dBA) was recorded and employed for further analysis. Results of the preliminary analysis of the data revealed that; though the noise level data are significantly homogeneous and devoid of possible outliers, they are not normally distributed owing to their stochastic nature. Multivariate analysis of the data revealed that; the calculated partial Eta squared of the Pillai's trace is 0.379 which indicates 37.90% variability among the dependent variables occasioned by change in the period of measurement. In addition, a Goodness of Fit Index (GFI) of 0.945, Normal Fit Index (NFI) of 0.900, Relative Fit Index (RFI) of 0.767, Comparative Fit Index (CFI) of 0.941 and Tucker-Lewis Index (TLI) of 0.863 obtained from the structural equation modelling (SEM) revealed that the confirmatory factor analysis showed an acceptable overall model fit and hence, the theorized model fit well with the observed data and the hypothesized factor CFA model fits the sample data and thus the null hypothesis was accepted and it was concluded that the difference in the observable noise level data is significant.

1. Introduction

Noise is inevitable. We come across it in our daily lives while driving, working and many routine activities. Many interact daily with machinery, either during working activities, or domestic chores, which produce noise levels large enough to be sources of environmental concern. The noise levels, which vary from place to place, are increasingly becoming a source of concern. The daily emergence of factories and huge mechanical industries coupled with the rapidly developing communities brings to light the various hazards and danger of working in a noise polluted environment. Modern life has given rise to a new form of pollution, noise, crowded cities and towns, mechanized means of transport, new devices for recreation and entertainment which are polluting the atmosphere with their continuous noise.

Noise is no doubt a normal phenomenon of life and is derived to be one of the most effective alarm systems in man's physical environment. However, it is continuously disturbing human peace and tranquility [1]. According to the World Health Organization, noise in big cities is considered the third most hazardous environmental type of pollution, preceded only by air (gas emission) and water pollution [2]. Considered largely as a major problem of annoyance in cities, the subject of noise pollution has been an unavoidable issue since the seventies. Pollution in large cities and constantly urbanized communities and towns is due to the fact that the urban environment is becoming increasingly crowded, busy and noisy. According to various researches that have been carried out, road traffic is the leading source of noise in urban areas [3]. It has been generally accepted that noise pollution, particularly road traffic noise is severe in rapidly expanding cities such as those of South-eastern and South- western Nigeria where insufficient control is exercised and cities are poorly planned [4].

The adverse effects of noise pollution are numerous and stretch over a wide range. It has far reaching effects on our mental and physical well-being. The length of exposure to the pollutant determines how badly an individual is affected by noise pollution. Noise pollution effects can be categorized into two: namely auditory and non-auditory. The adverse effects of noise pollution observed are as a result of continuous constant exposure to it. Auditory effects also known as physical effects hearing defects. Non-auditory effects are associated with effects on work performance, such as reduction of productivity and misunderstanding what is heard; psychological effects such as disorders, sleeplessness, irritability and stress; physiological effects, such as increased blood pressure, irregularity of heart rhythms and ulcers. Noise pollution can play havoc with the nervous system affecting the physical and psychological behaviour of individuals. People differ in their sensitivity to noise, in that, what one perceives to be sound may be perceived as noise by another.

2.0 Research Methodology

2.1 Description of study area

The study area is Warri, a popular city in Delta state, Nigeria located between latitude $5^{o}\ 31^{I}\ 0^{II}$ N and longitude $5^{o}\ 45^{I}\ 0^{II}$ E. It has a population of 611,970 according to the 2018 population census. It shares boundaries with Sapele, Okpe, Uvwie, Udu and Ughelli although most of these places have integrated to the larger cosmopolitan Warri.

Warri town is underlain by a sequence of sedimentary formations with a thickness of about 8000metres, which include from bottom to top, the Akata Formation, the Agbada Formation, the Benin Formation and the Somebreiro Warri Deltaic Plain Sands [5,6,7].

The Akata Formation rests unconformably on the migmatite-gneiss basement complex and forms the basal unit of the Niger Delta stratigraphic pile. This formation consists of an open marine facies unit dominated by high-pressured carbonaceous shales. The formation ranges in age from Paleocene to Eocene and its thickness could exceed 1000 meters. The Agbada Formation consists of a sequence of alternating deltaic sands and shales. It is Eocene to Oligocene in age and exceeds 3000 meters in thickness. This formation is the oil –reservoir in the Niger Delta basin. The Benin Formation which is Oligocene to Pleistocene in age consists essentially of massive and highly porous sands and gravels with a few thin clay intercalations. Its uppermost section is the quaternary deposit which is about 40-150m thick and comprises rapidly alternating sequences of sand and silt/clay with the later becoming increasingly more prominent seawards [8]. The Benin Formation houses the most productive and hence most tapped aquifer in the Niger Delta region, especially in areas north of Warri where it is shallow. The thickness of the formation is variable, but generally exceeds 2000m. The google earth map of the study area is presented in Figure 1.

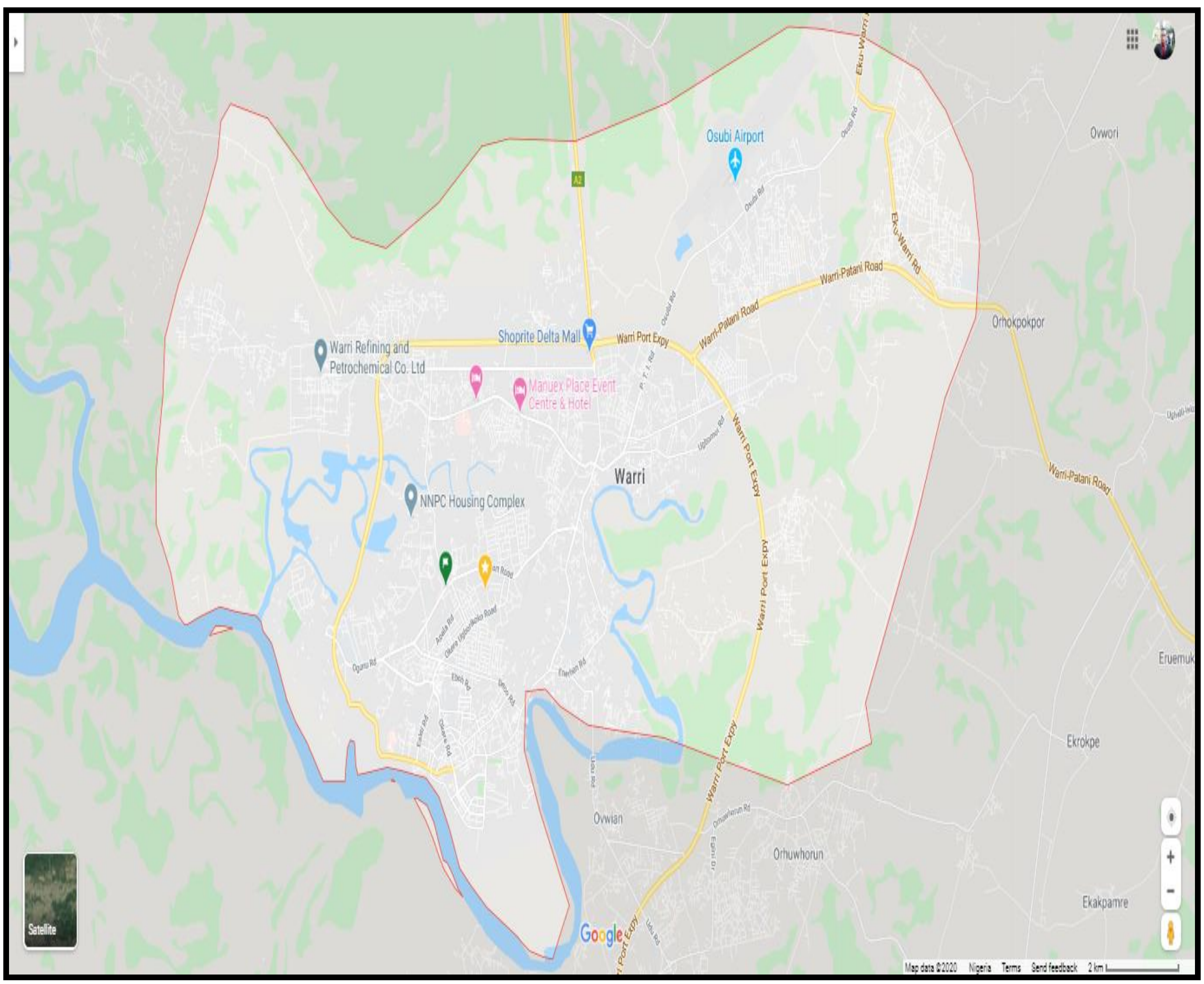


Figure 1: Google Earth map of the study area

2.2 Data Collection

Basic equipment employed for data collection are presented in Table 1

Table 1: Equipment's used for data collection

S/N	Equipment Name	Model	Location	Purpose
1	Noise meter	CR811C	Warri	For measuring noise levels
2	Hand– Held GPS	Garmin Oregon 650t	Warri	For measuring elevations, longitudes and latitudes of point locations
3	Infrared thermometer	Flute 572-2	Warri	For measuring the temperature at a spot on a surface

In carrying out the noise level measurements, 10 locations comprising of commercial, industrial activities and busy roundabouts were selected for this study. The measurement of sound level was carried out using a type 1 integrated sound level meter accompanied with a Garmin Oregon 650t hand-held GPS. The CR811C noise level meter was held at a height of 1.2m above ground level with the antenna pointing to the sound source. The measurement process was carried out for the 10 locations at two times a day which are: 7.00am – 9.00am and 5.00pm – 7.00pm. The instrument was set at the A-weighting network and the equivalent noise level (Leq) which is the constant noise level that expands the same amount of energy over the same period, was measured for the various locations. Noise measurements was done for ten (10) weeks (70days) between march to May 2021 for each of the 10 locations at mornings and evenings and the weekly average noise level in (dBA) was recorded and employed for further analysis.

2.3 Data Analysis

Preliminary analysis methods employed include; descriptive statistics aimed as investigating the variation between the mean of the data and the standard deviation, test of normality aimed at assessing the trend and nature of data distribution, outlier detection aimed at investigating the presence of abnormallity in the form of outlier, homogeneity test aimed at confirming that the data collected are from same population distribution and finally autocorrelation test which was employed to determine the presence of errors and its distribution.

2.3.1 Test of normality

For normality;

i. The skewness and kurtosis significant values must be close to zero as possible
ii. The computed skewness and kurtosis Z-values must be between -1.96 and +1.98
iii. The histogram and Q-Q plot should visually indicate that the data are approximately normally distributed
iv. The computed Shapiro-Wilk and Kolmogorov- Smirnov significant values should be greater than 0.05 ($p < 0.05$)

2.3.2 Outlier detection test result

For outlier detection analysis, the labelling rule method which utilizes the 25th percentile (lower bound) and the 75th percentile (upper bound). was employed. The underlying mathematics of the labelling rule method is presented as follows [9].

$$\textit{Lower Bound}\ Q_1 - (2.2 \times (Q_3 - Q_1) \quad (1)$$

$$\textit{Upper}\ \text{Bound}\ Q_3 + (2.2 \times (Q_3 - Q_1) \quad (2)$$

At 0.05 degree of freedom, any data lower than Q_1 or greater than Q_3 was considered an outlier and was removed before further analysis.

2.3.3 Autocorrelation Test

To investigate the presence of temporal variation in the noise level data and possibly check for the occurence of trend, the autocorrelation plots and autocorrelation function were generated from the correlogram of noise level data using EViews 9.0 [10].

2.3.4 Homogeneity test

Homogeneity test was done to ascertain the fact that the dependent variables; noise level data are from the same population distribution. The underlying statistics of homogeneity was formulated as follows [11].

H0: Data are statistically homogeneous

H1: Data are not homogeneous

The null and alternate hypothesis were tested at 90%, 95% and 99% confidence interval that is 0.1, 0.05 and 0.01 degree of freedom

2.3.5 Multivariate analysis of vehicular noise pollution data

To study the variation in the concentration of vehicular noise pollution occasioned by temporal variability (time of measurement), multivariate analysis of variance (MANOVA) was employed. Analysis of temporal variability is needed to ascertain if the difference in concentration of vehicular noise pollution measured at the early hours of the morning and that measured at peak hour of evening is significant. To employ MANOVA, its suitability was first ascertained using the degree of multivariate alliance associated with the data. Multivariate alliance was calculated through a measure known as the Mahalanobis constant. If the maximum calculated value of the Mahalanobis constant is less than the critical value, then the assumption of multivariate outliers has not been violated. Therefore, if multivariate outliers have not been violated, then we can investigate the concept of temporal variability using multivariate analysis of variance (MANOVA) [9]. To justify the presence of temporal variability and account for the percentage variability multivariate test statistics based on Pillai's Trace approach was employed.

2.3.7 Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis (CFA) is a multivariate statistical procedure that is used to test how well the measured variables represent the number of constructs. Confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) are similar techniques. In exploratory factor analysis (EFA), data is simply explored and provides information about the numbers of factors required to represent the data while confirmatory factor analysis (CFA) technique is used to confirm the factors and validate the model. The purpose of CFA is twofold: to confirm a hypothesized factor structure, and as a validity procedure in the measurement of model. The model fit in CFA was conducted using the maximum likelihood prediction methodology which is dependent on the multivariate normality that reproduces the correct measure of associations among the latent variables [11]. CFA Analysis Flowchart adopted for this study is presented in Figure 2.

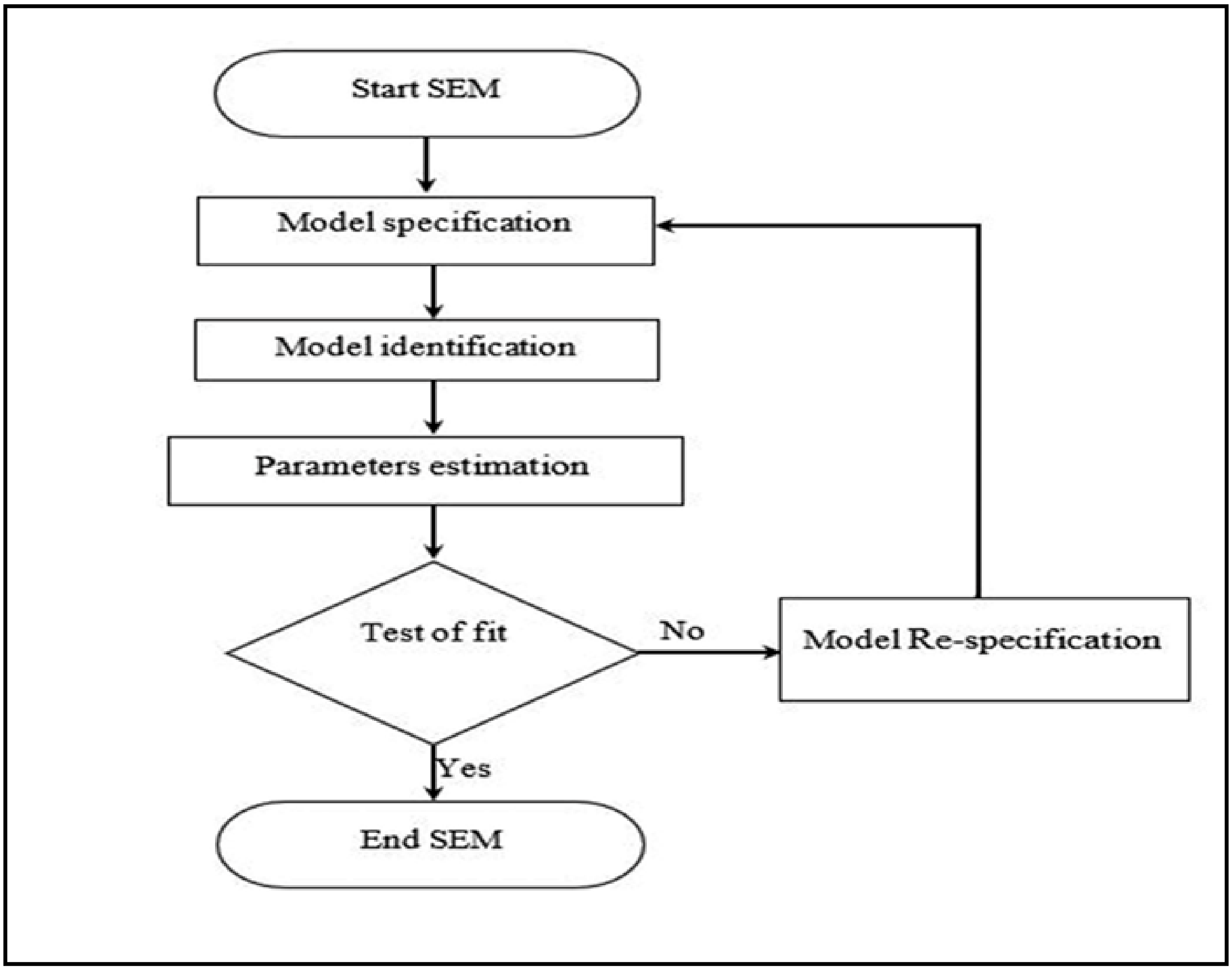


Figure 2: CFA Analysis Flowchart (Source: Alaloul *et al*., 2020)

3.0 Results and Discussion

The descriptive statistics of the mean vehicular noise pollution data is presented in Tables 2 and 3 representing data for morning and evening respectively.

Table 2: Descriptive statistics of mean vehicular noise data (Morning)

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MON	10	23	67	90	81.40	2.441	7.720	59.600	-.789	.687	-.606	1.334
TUE	10	20	69	89	77.60	2.061	6.518	42.489	.111	.687	-.530	1.334
WED	10	17	70	87	80.50	1.727	5.462	29.833	-.841	.687	-.233	1.334
THUR	10	15	71	86	79.20	1.806	5.712	32.622	-.201	.687	-1.778	1.334
FRI	10	11	75	86	78.90	1.260	3.985	15.878	1.040	.687	-.464	1.334
SAT	10	21	69	90	81.20	2.356	7.451	55.511	-.793	.687	-.446	1.334
SUN	10	30	59	89	71.20	3.309	10.465	109.511	.352	.687	-1.198	1.334
Valid N (listwise)	10											

Table 3: Descriptive statistics of mean vehicular noise data (Evening)

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
MON	10	26	61	87	77.30	2.829	8.945	-.888	.687	-.471	1.334
TUE	10	36	51	87	74.00	3.550	11.225	-1.070	.687	.680	1.334
WED	10	36	50	86	72.30	3.736	11.814	-.996	.687	-.369	1.334
THUR	10	33	50	83	72.10	3.653	11.551	-1.146	.687	.017	1.334
FRI	10	35	50	85	72.00	3.899	12.329	-1.155	.687	.151	1.334
SAT	10	28	57	85	75.10	3.513	11.110	-.812	.687	-1.175	1.334
SUN	10	25	57	82	72.20	2.485	7.857	-.600	.687	-.180	1.334
Valid N (listwise)	10										

From the result of Table 2 and 3, it was observed that the noise level within the study area ranges from 67-90 dBA on Monday morning and 61-87 dBA on Monday evening. For Tuesday the noise level was between 69-89 dBA in the morning and 51-87 dBA in the evening. For Wednesday, the noise level was observed to be between 70-87 dBA in the morning and 50-87 dBA in the evening. For Thursday, the noise level was observed to be between 71-86 dBA in the morning and 50-83 dBA in the evening. For Friday, the noise level was observed to be between 75-86 dBA in the morning and 50-85 dBA in the evening. For Saturday, the noise level was observed to be between 69-90 dBA in the morning and 57-85 dBA in the evening. Finally, on Sunday, the noise level was observed to be between 59-89 dBA in the morning and 57-82 dBA in the evening. The variation in the noise level may be attributed to temporal variability occasioned by time of measurement.

A further assessment of the influence of temporal variability was done using the difference in the mean ± standard deviation. Using the noise pollution data for Monday, the observable mean ± standard deviation for morning and evening session was (81.40±7.720) and (77.30±8.945). Using the noise pollution data for Tuesday, the observable mean ± standard deviation for morning and evening session was (77.60±6.518) and (74.00±11.225). Using the noise pollution data for Wednesday, the observable mean ± standard deviation for morning and evening session was (80.50±5.462) and (72.30±11.814). Using the noise pollution data for Thursday, the observable mean ± standard deviation for morning and evening session was (79.20±5.712) and (72.10±11.551). Using the noise pollution data for Friday, the observable mean ± standard deviation for morning and evening session was (78.90±3.985) and (72.00±12.329). Using the noise pollution data for Saturday, the observable mean ± standard deviation for morning and evening session was (81.20±7.451) and (75.10±11.110). Using the noise pollution data for Sunday, the observable mean ± standard deviation for morning and evening session was (71.20±10.465) and (72.20±7.857). Again, based on the difference in the mean ± standard deviation of the noise level data, we concluded that; there exist the presence of temporal variability occasioned by time of measurement.

Using the ratio of standard deviation to mean, coefficient of variability (CV) was calculated in other to evaluate the variation of noise level for both morning and evening season. The computed CV for both morning and evening on Monday was observed to be (0.0948 and 0.1157). The computed CV for both morning and evening on Tuesday was observed to be (0.0840 and 0.1517). The computed CV for both morning and evening on Wednesday was observed to be (0.0679 and 0.1634). The computed CV for both morning and evening on Thursday was observed to be (0.0721 and 0.1602). The computed CV for both morning and evening on Friday was observed to be (0.0505 and 0.1712). The computed CV for both morning and evening on Saturday was observed to be (0.0918 and 0.1479). The computed CV for both morning and evening on Sunday was observed to be (0.14698 and 0.10882). The observed difference in the computed coefficient of variation accounted for the influence of temporal variability on the noise level within the study area.

The computed statistics based on Shapiro-Wilk and Kolmogorov- Smirnov significant values is presented in Tables 4 and 5 representing morning and evening respectively

Table 4: Normality test of noise pollution data (Morning)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
MON	.224	10	.167	.897	10	.204
TUE	.156	10	.200*	.935	10	.499
WED	.236	10	.120	.906	10	.253
THUR	.219	10	.192	.891	10	.173
FRI	.289	10	.017	.823	10	.027
SAT	.195	10	.200*	.885	10	.148
SUN	.200	10	.200*	.901	10	.223

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Table 5: Normality test of noise pollution data (Evening)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
MON	.275	10	.030	.884	10	.146
TUE	.205	10	.200*	.911	10	.286
WED	.323	10	.004	.828	10	.032
THUR	.264	10	.046	.833	10	.037
FRI	.215	10	.200*	.830	10	.034
SAT	.270	10	.037	.819	10	.025
SUN	.170	10	.200*	.942	10	.578

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

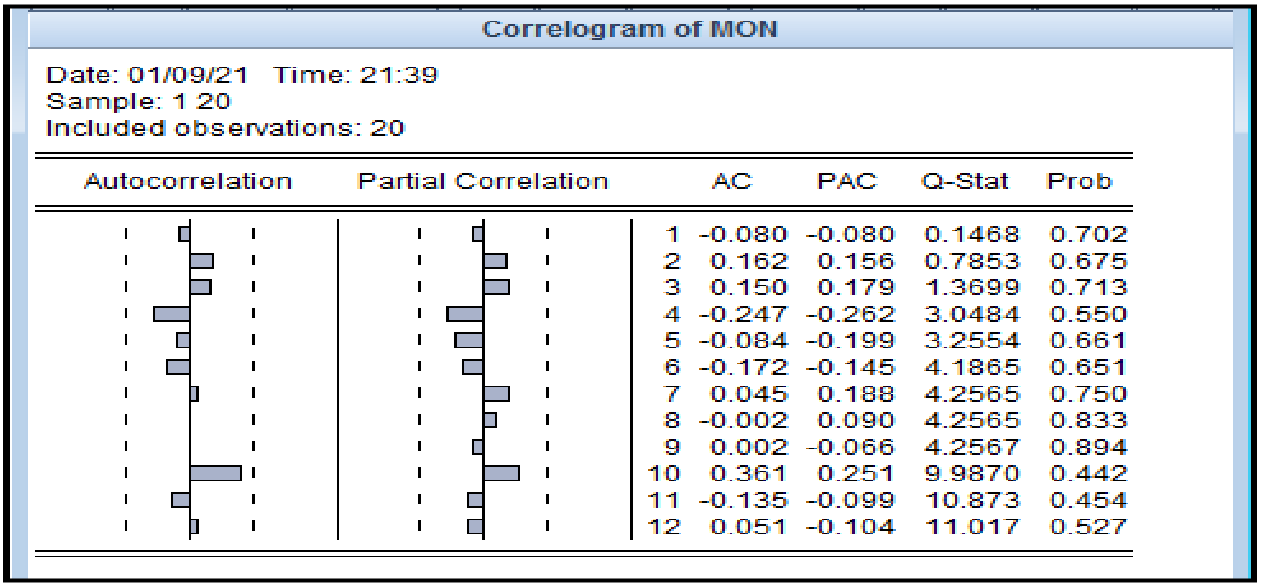
Since the calculated p-value based on Kolmogorov- Smirnov and Shapiro-Wilk test for noise level data collected during most time of the day had calculated p-value greater then 0.05, it was concluded that the noise level data did not follow the bell shape configuration reminiscence of the popular normal distribution curve. Hence, the data are not normally distributed.

For outlier detection analysis, the upper bound and lower bound statistics were calculated and result obtained is presented in Table 6 .

Table 6: Calculated upper and lower bound statistics

Time	Computed percentile	Lower and upper bound statistics	Computed lower and upper bound	Extreme value statistics
Week 1	25th = 73.25 75th = 86.75	73.25 – (2.2 (86.75-73.25)) 86.75 + (2.2 (86.75-73.25))	Lower Bound = 43.55 Upper Bound = 112.05	Lowest value = 61 Highest value = 90
Week 2	25th = 70.25 75th = 80.75	70.25 – (2.2 (80.75-70.25)) 80.75 + (2.2 (80.75-70.25))	Lower Bound = 47.15 Upper Bound = 103.85	Lowest value = 51 Highest value = 89
Week 3	25th = 75.00 75th = 83.50	75.00 – (2.2 (83.50-75.00)) 83.50 + (2.2 (83.50-75.00))	Lower Bound = 56.30 Upper Bound = 102.20	Lowest value = 57 Highest value = 87
Week 4	25th = 71.50 75th = 82.50	71.50 – (2.2 (82.50-71.50)) 82.50 + (2.2 (82.50-71.50))	Lower Bound = 47.30 Upper Bound = 106.70	Lowest value = 50 Highest value = 86
Week 5	25th = 74.25 75th = 81.00	74.25 – (2.2 (81.00-74.25)) 81.00 + (2.2 (81.00-74.25))	Lower Bound = 59.40 Upper Bound = 95.85	Lowest value = 60 Highest value = 86
Week 6	25th = 70.00 75th = 84.75	70.00 – (2.2 (84.75-70.00)) 84.75 + (2.2 (84.75-70.00))	Lower Bound = 37.55 Upper Bound = 117.2	Lowest value = 57 Highest value = 90
Week 7	25th = 66.00 75th = 80.00	66.00 – (2.2 (80.00-66.00)) 80.00 + (2.2 (80.00-66.00))	Lower Bound = 29.20 Upper Bound = 110.80	Lowest value = 57 Highest value = 89

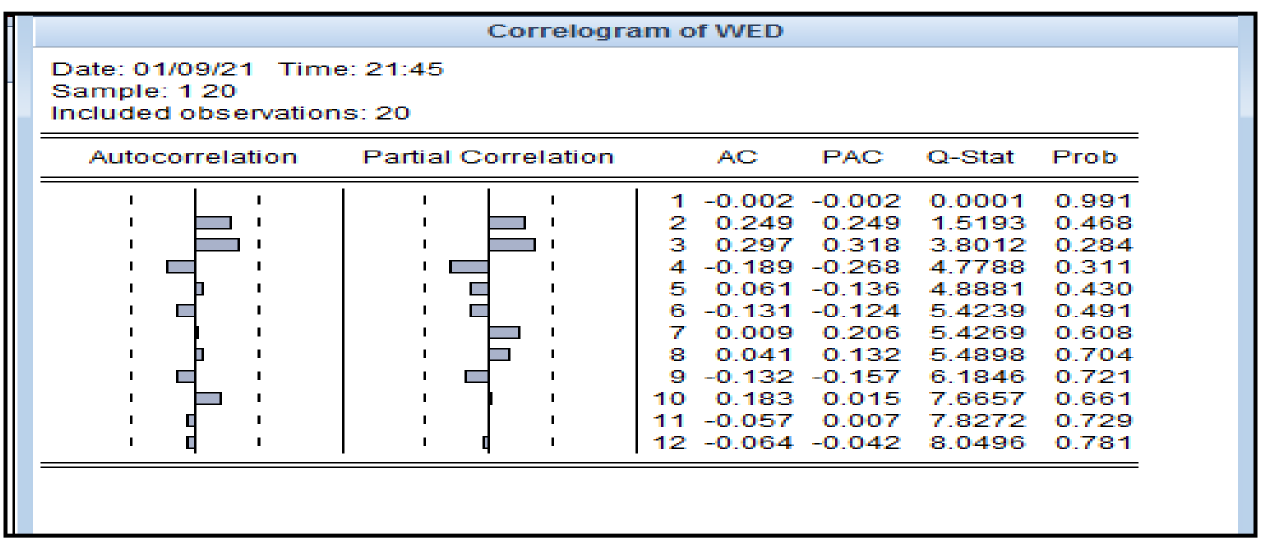
Using the extreme value statistics, the lowest noise level data were observed to be 62, 53, 58, 52, 62, 58, and 58 representing week 1, 2, 3, 4, 5, 6 and 7. While the highest noise level data are; 89, 88, 85, 85, 85, 88 and 87 also representing the maximum noise level for week 1, 2, 3, 4, 5, 6 and 7. Based on the results of Table 6, it was concluded that the data used are devoid of possible outliers since no value is lower than the calculated lower bound or higher than the calculated upper bound. To validate the presence of temporal variation in the data and possibly check for the occurence of trend, the autocorrelation plots and autocorrelation function were generated from the correlogram of noise level data using EViews 9.0. Results of the autocorrelation plot of the noise level data is presented in Figures 3 and 4 respectively representing morning and evening


Correlogram of MON

Date: 01/09/21 Time: 21:39
Sample: 1 20
Included observations: 20

	AC	PAC	Q-Stat	Prob
1	-0.080	-0.080	0.1468	0.702
2	0.162	0.156	0.7853	0.675
3	0.150	0.179	1.3699	0.713
4	-0.247	-0.262	3.0484	0.550
5	-0.084	-0.199	3.2554	0.661
6	-0.172	-0.145	4.1865	0.651
7	0.045	0.188	4.2565	0.750
8	-0.002	0.090	4.2565	0.833
9	0.002	-0.066	4.2567	0.894
10	0.361	0.251	9.9870	0.442
11	-0.135	-0.099	10.873	0.454
12	0.051	-0.104	11.017	0.527

Figure 3: Autocorrelation test of noise level data (Morning)


Correlogram of WED

Date: 01/09/21 Time: 21:45
Sample: 1 20
Included observations: 20

	AC	PAC	Q-Stat	Prob
1	-0.002	-0.002	0.0001	0.991
2	0.249	0.249	1.5193	0.468
3	0.297	0.318	3.8012	0.284
4	-0.189	-0.268	4.7788	0.311
5	0.061	-0.136	4.8881	0.430
6	-0.131	-0.124	5.4239	0.491
7	0.009	0.206	5.4269	0.608
8	0.041	0.132	5.4898	0.704
9	-0.132	-0.157	6.1846	0.721
10	0.183	0.015	7.6657	0.661
11	-0.057	0.007	7.8272	0.729
12	-0.064	-0.042	8.0496	0.781

Figure 4: Autocorrelation test of noise level data (Evening)

Autocorrelation plot and the partial autocorrekation plot indicate the presence of temporal variation in the data. seasonality occurs when the data points are scattered on both sides of the line as observed in Figures 3 and 4. If the values of the computed autocorrelation function (AC) decreases or fluctuates steadily from top to bottom and tend towards zero, then you can conclude that trend exist in the data otherwise you declear that no observable trend exist in the data. From the results of Figures 3 and 4, it was observed that the calculated autocorrelation functions fluctuates steadily from top to bottom. Hence it was concluded that there exist the presence of trend and variability in the noise level data.

For homogeneity of the noise level data, the null and alternate hypothesis was tested at 90%, 95% and 99% confidence interval that is 0.1, 0.05 and 0.01 degree of freedom and result obtained is presented in Figures 5 and 6 representing measured noise level in the morning and evening respectively.

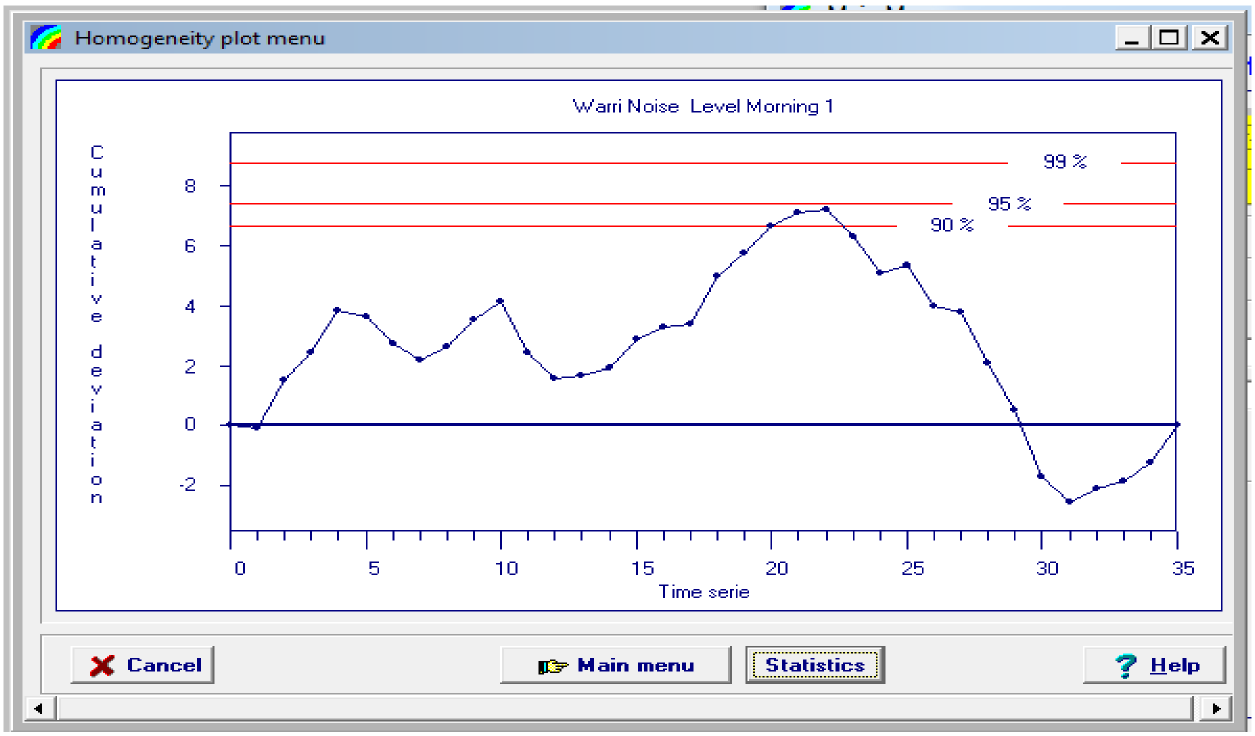


Figure 5: Homogeneity test of noise level data (Morning)

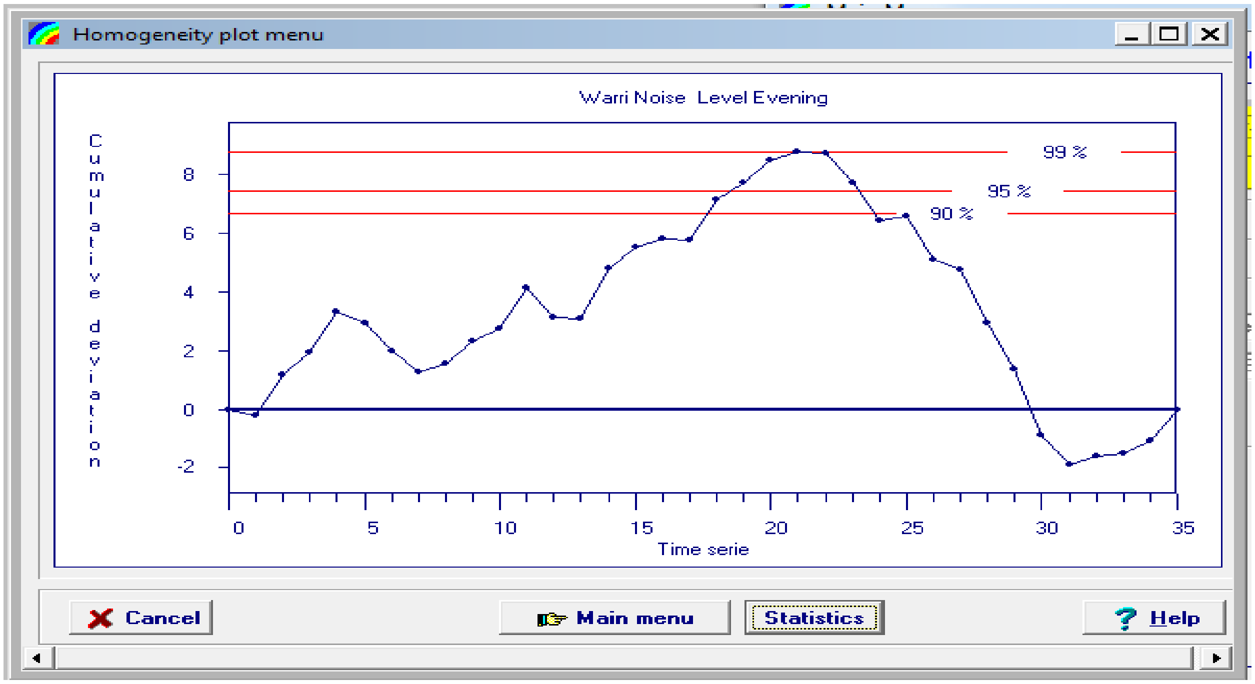


Figure 6: Homogeneity test of noise level data (Evening)

From the result of Figures 5 and 6, it was observed that the noise level data fluctuates around the zero-center line of the residual mass curve an indication that the data are statistically homogeneous. In multivariate analysis of variance, we set out to test the null hypothesis that observed covariance matrix of all the dependent variables (noise level data) are equal across group (morning and evening) that is; there is no variation in the measured noise level as a function of time. If the calculated p-value is less than 0.05 ($p < 0.05$) we reject the null hypothesis and conclude that the assumption of equal covariance matrices across group has not been satisfied; an indication that temporal variability exists among the group. The multivariate test statistics computed to study the effect of temporal variability is presented in Table 7.

Table 7: Result of multivariate statistics

Multivariate Tests[c]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Intercept	Pillai's Trace	.991	1.996E2[a]	7.000	12.000	.000	.991	1397.192	1.000
	Wilks' Lambda	.009	1.996E2[a]	7.000	12.000	.000	.991	1397.192	1.000
	Hotelling's Trace	116.433	1.996E2[a]	7.000	12.000	.000	.991	1397.192	1.000
	Roy's Largest Root	116.433	1.996E2[a]	7.000	12.000	.000	.991	1397.192	1.000
Group	Pillai's Trace	.379	1.048[a]	7.000	12.000	.449	.379	7.333	.280
	Wilks' Lambda	.621	1.048[a]	7.000	12.000	.449	.379	7.333	.280
	Hotelling's Trace	.611	1.048[a]	7.000	12.000	.449	.379	7.333	.280
	Roy's Largest Root	.611	1.048[a]	7.000	12.000	.449	.379	7.333	.280

a. Exact statistic

b. Computed using alpha = .05

c. Design: Intercept + Group

From the result of Table 7, it was observed that the computed significant value (p-value) based on Roy's largest root, Wilk's Lambda, Hotelling's Trace and the Pillai's Trace were less than 0.05 (p = 0.00) hence, the null hypothesis that the noise level data are the same for the two groups (morning and evening) was rejected and it was concluded that temporal variability actually exist. To calculate the percent variability that is accounted for due to temporal variation, the partial Eta squared value of the Pillai's trace was employed. From the result of Table 3.5, the calculated partial Eta squared of the Pillai's trace was observed to be 0.379 which indicates 37.90% variability among the dependent variables occasioned by change in the period of measurement.
Multivariate analysis of variance was employed to establish that; there is about 37.90% variation between the noise level data recorded in the morning and the one recorded in the evening. To ascertain that this observable difference is statistically significant, confirmatory factor analysis using maximum likelihood estimation of the structural equation modelling was done. The part diagram for the structural equation modelling is presented in Figure 7.

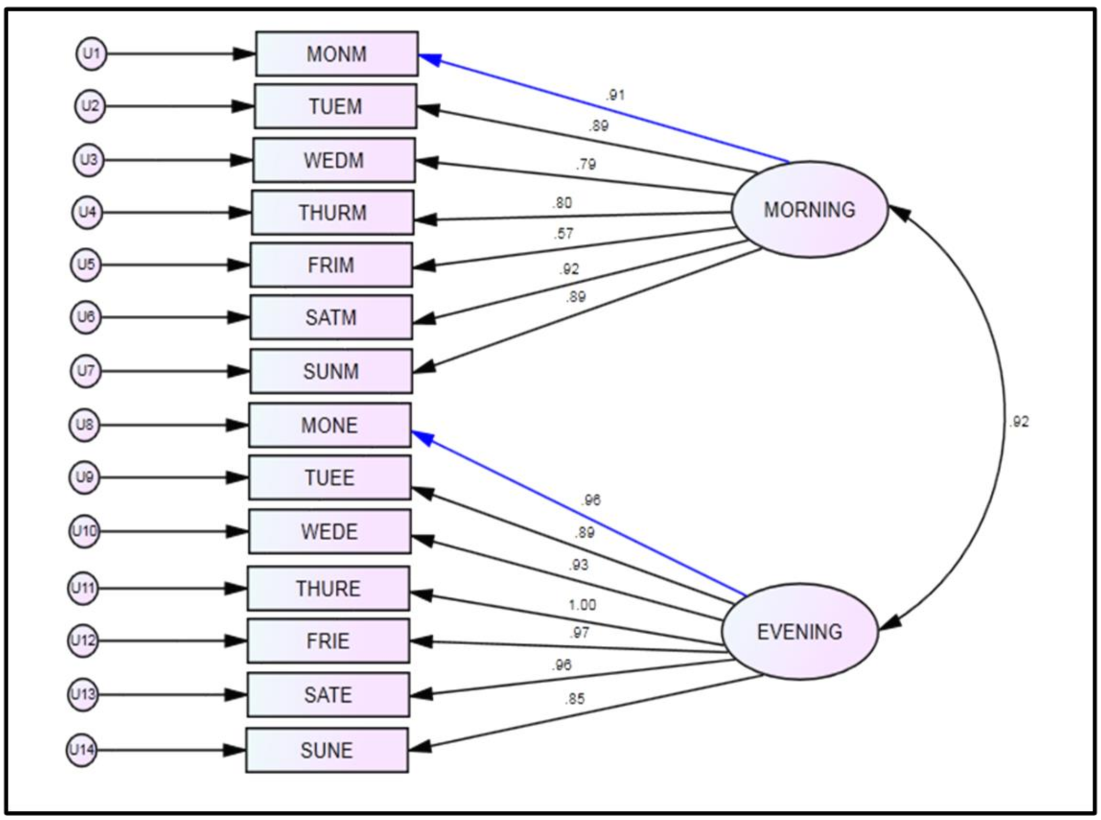


Figure 7: SEM path diagram for noise level analysis

From the estimates, it was observed that the correlation between noise level data in the morning and evening is 0.92. The high correlation coefficient allows for the estimation of the model fit statistics. To evaluate the adequacy of the model in explaining the validity of the outcome of MANOVA, model-fit statistics adopted from the works of previous researchers presented in Table 8 was employed.

Table 8: Fit statistics of model measurement

S/n	Fit statistics	Recommended
1	CMIN (Minimum discrepancy function)	-
2	DF (Degree of freedom)	-
3	CMIN Significance (Model probability value)	p < = 0.05
4	CMIN/DF	< 5.0 (Bentler and Bonnett, 1980)
5	GFI (Goodness of Fit Index)	> 0.80 (Joreskog & Sorbom, 1981
6	AGFI (Adjusted Goodness of Fit Index)	> 0.80 (Joreskog & Sorbom, 1981
7	NFI (Normal Fit Index)	> 0.90 (Bentler and Bonnet 1980)
8	RFI (Relative Fit Index)	> 0.90 (Bollen, 1986)
9	CFI (Comparative Fit Index)	> 0.90 (Hu and Bentler 1999)
10	TLI (Tucker-Lewis Index)	> 0.90 (Tucker and Lewis, 1973)
11	RMSEA (Root-mean-square error of approximation	< 0.06 (Browne and Cudeck, 1993)

Using the recommended fit statistics of model measurement, the overall result of the model was generated and presented in Table 9.

Table 9: CFA modelling result

S/n	Fit statistics	Recommended	Obtained
1	CMIN (Minimum discrepancy function)	-	25.284
2	DF (Degree of freedom)	-	12
3	CMIN Significance (Model probability value)	p < = 0.05	0.014
4	CMIN/DF	< 5.0 (Bentler and Bonnett, 1980)	2.107
5	GFI (Goodness of Fit Index)/IFI	> 0.80 (Joreskog & Sorbom, 1981	0.945
7	NFI (Normal Fit Index)	> 0.90 (Bentler and Bonnet 1980)	0.900
8	RFI (Relative Fit Index)	> 0.90 (Bollen, 1986)	0.767
9	CFI (Comparative Fit Index)	> 0.90 (Hu and Bentler 1999)	0.941
10	TLI (Tucker-Lewis Index)	> 0.90 (Tucker and Lewis, 1973)	0.863

From the results of Table 9, it was observed that the statistical parameters of the model are good. It was concluded that the confirmatory factor analysis showed an acceptable overall model fit and hence, the theorized model fit well with the observed data and the hypothesized factor CFA model fits the sample data and thus the null hypothesis was accepted and it was concluded that the difference in the observable noise level data is significant.

4.0 Conclusion

In this study, modelling, analysis and prediction of noise level pollutants from vehicular emission in some selected locations around Warri in Delta State was done. To certify the adequacy of the field data, selected preliminary analysis, namely; descriptive statistics, test of normality, outlier detection autocorrelation and homogeneity test was done. In other to establish the presence of temporal variability associated with the noise level data, exploratory factor analysis using multivariate analysis of variance was done and it was established by means of the Partial Eta Square of the Pillai's Trace statistics that about 37.90% variability exist among the dependent variable. On whether the outcome of the multivariate analysis is significant, result of confirmatory factor analysis was employed to validate the adequacy of the outcome of exploratory factor analysis and re-established the variability in noise pollution occasioned by time of measurement. Result of the confirmatory factor analysis showed an acceptable overall model fit and hence, the theorized model fit well with the observed data and the hypothesized factor CFA model fits the sample data and thus the null hypothesis was accepted and it was concluded that the difference in the observable noise level data is significant.

5.0 References

[1] Nejadkoorki, F; Yousefi, E and Naseri, F (2010) Analysing Street Traffic Noise Pollution in The City of Yazd. Department of Environmental Engineering, Yazd University, Yazd, Iran, pp 45-56

[2] World Health Organization (WHO, 2005). United Nations Road Safety Collaboration: A Handbook of Partner Profiles, pp: 47-62

[3] Saadu, A.A., Onyeonwu R. O, Ayorinde E. O and Ogisi F. O (1998). Road Traffic Noise Survey and Analysis of Major Urban Centres in Nigeria, Noise Control Engineering Journal, 46: 146-158.

[4] Onuu, M.U., (1992) Measurements and Analysis of Road Traffic Noise and its Impacts in Parts of South Eastern Nigeria. Ph.D Thesis, University of Calabar, Calabar, Cross River State, Nigeria.

[5] Raes, D; Willens, P and Gbaguidi (2006), Rainbow – A software package for analyzing data and testing the homogeneity of historical data sets, vol. 1, pp: 1-15

[6] Levi, D. B.; Julie, E. K.; Olsen, J. R.; Pulwarty, R. S.; Raff, D. A.; Turnipseed, D. P.; Webb, R. S and Kathleen D. W (2009); Climate Change and Water Resources Management: A Federal Perspective, circular 1331, pp: 1 – 72

[7] Alaloul, W. S; Liew, M. S; Zawaai, N. A. W; Mohammed, B. S; Adamu, M and Musharat, M. A (2020), Structural Equation Modelling of construction project performance based on coordination factors, Cogent Engineering, accessed at https://dol.org/10.1080/23311916.20 20.1726069.

[8] Alkarkhi AFM, Ahmad A, Ismail N, Easa A and Omar K (2008): "Assessment of surface water through Multivariate Analysis." Journal of Sustainable Development, Vol. 1(3), pp, 27-33.

[9] Shrestha S and Kazama F (2007); "Assessment of surface water quality using multivariate statistical techniques: A case study of the Fuji river basin, Japan." Environmental Modelling and Software, vol. 22(4), pp, 464-475.

[10] Allen, J.R.L (1965). Late Quaternary Niger Delta and Adjacent Areas: Sedimentary Environments and Lithofacies. Bulletin. AAPG Vol. 49, pp. 547-600.

[11] Hamed, K. H. and Rao, A. R., (2008): A modified Mann- Kendall trend test for auto correlated data, Journal of Hydrology, vol. *204*, (1-4), pp: 182–196