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Original Articles

- **Socio-economic and Political Drivers of Renewable Natural Resource Conflicts among Crop Farmers in Southeast Nigeria**  
J.U Chikaire, C.N Atoma, J.O Ajaero  
46-51
- **Climate Change Vulnerability Assessment: An Evaluation of Social Dimension**  
Auwal Garba, Bukar Abba Gana, Isah Mohammed, Haruna Adamu  
52-61
- **Ponds' Water Quality Analysis and Impact of Heavy Metals on Fishes' Body**  
J.D. Ndayisenga, S. Dusabe  
62-72
- **Study of Ichthyofauna: Fishes in the Enipeas River's Catchment Area, Central Macedonia, Greece**  
Konstantinos Fytilis, Evangelos Palatos  
73-76
- **Energy Consumption Analysis in the Plastic Waste Recycling Process: A Case Study of Amazia Vision Enterprise Private Limited, Satara, India**  
Tanmay Ghadge, Vrushti Khare, Shailesh Bhosale, Prashant A Giri, Vikas Jadhav  
77-83
- **Socio-economic Impacts of Rural Energy Poverty on Women and Students in Esa-Oke, Nigeria**  
Ayomide Samuel Famewo, Vincent Abimbola Uwala  
84-93
- **Graphene Oxide Nanocomposite for Sustainable Pure Water by PES Membrane**  
Khalefa A. Faneer, Ebrahim Mahmoudi, Muneer Ba-Abbad, Rosiah Rohani  
94-98
- **Impact of Climate Change on Gujjar and Bakarwal Communities of Jammu and Kashmir**  
Sajad Ahmad Mir, Maliha Batool
- **Clean Transport Network in Nigerian Environment: Climatic Issues and Way Forward**  
Oluwadare Joshua Oyebode  
105-111
- **Using Fishermen's Knowledge and GIS to Identify Fishing Grounds, Gears and Species in the Projected Marine Protected Area 'Jabal Moussa'**  
Mohamed Rida Derdabi, Mustapha Aksissou, Ihssane Toujgani  
112-119
- **Properties of Upgraded Bio-oil from Pyrolysis of Waste Corn Cobs**  
Michael Terungwa Abatyough, Victor Olatunji Ajibola, Edith Bolanle Agbaji, Zakka Israila Yashim  
120-128
- **Assessment of Compliance with Preliminary Environmental Investigations for Erecting Sustainable Building Structure in Abuja Metropolis, Nigeria**  
M. B. Ibrahim, I. Dauda, C. O. Igwe, A. M. Hassan  
129-135
- **Analysis of Trace Metals in Hand Dug Wells around Dumpsites in Okene Metropolis, Nigeria**  
Omeiza Samuel Folorunsho, Adebayo Albert Ojo, Adebayo Mathew Ayorinde, Ajayi Olubode Olumuyiwa  
136-143



- Utilization of Safety Facilities in Building Construction Sites in Federal Capital Territory Abuja and Niger State, Nigeria  
Umar Garba, D. Ibrahim, W.B Kareem  
144-150
- Impact of Climate and Land Use Changes on the Livelihood of Residents in Calabar River Basin, South-eastern Nigeria  
Ibiso Michael Inko Tariyah, Temple Probyne Abali, Leonard Michael Onyinyechi Aminigbo  
151-160
- Implication of FIFA 2022 on Active Living and Environmental Changes: A Managerial Perspective  
Girish K. Nair  
161-175
- Bridging the Gaps of Clean Mobility and Transport through Engineering Interventions  
Oluwadare Joshua Oyeboode  
176-181
- Tree Growth Analysis as a Panacea for Sustainable Forest Management in Northeast Nigeria: Study of Lannea Kerstingii (Anacardiaceae)  
Justus Eronmosele Omijeh  
182-187
- Analysis of Environmental Impact and Waste Management of Egg Poultry Industry in the Philippines: A Case of San Jose, Batangas  
Ramces M. Dili, Ruthra Mae B. Kalaw, Anne Dominique L. Miguel, Gloria M. Ting  
188-196
- Integrated Management of Construction and Demolition Waste as Key Factor of Urban Circular Economy  
Samourkasidou Elena, Kitis Konstantinos, Gkiouzepas Giorgos  
197-209
- Appraisal of Socio-economic, Infrastructural and Environmental Impacts of Flood in Makurdi Local Government Ares of Benue State, Nigeria  
Tertese Peter Ikyapa, Adnan Abdulhamid, Tasi'u Yalwa Rilwanu, Mala Muhammed Daura, Philip Aondosoor Alogo  
210-217
- Effects of Palm Leaf Ash and Palm Kernel Fibre on Properties of Compressed Laterite Earth Brick  
K. Jude, C. O. Igwe, B. M. Mohammed  
218-223
- Measurement of Activity Concentration of 40K, 226Ra and 232Th in Commercial Wall Paints Used in Nigeria and Inherent Radiological Hazards  
E. O. Echeweozo, G. M. Onwunyiriwa, P. A. Nwigwe  
224-232
- Environmental Impacts of Automotive Air Conditioning System Maintenance Practices Embraced by Service Technicians in Niger State, Nigeria  
U O Ogunleye, R Audu, A M Hassan, M Abdulkadir  
233-240
- Determination of Heavy Metals Concentration in Soil and Leafy Vegetables in Urban Expressway and Peri-urban Road Farms of Lagos State, Nigeria

Peter Sanjo Adewale, Sunday Clement Olubunmi Makinde, Victor Owolola  
Kusemiju, Olawole O. Obembe  
241-246

- **Assessment of Task, Activities and Working Materials Used in Non-Formal Training of Solar and Satellite System Installation in Niger State**  
J. I. J. Kuta, O. O. Yusuf, E. Raymond  
247-256
- **Coconut Tree (Cocos nucifera) Products: A Review of Global Cultivation and its Benefits**  
H. Mary Henrietta, K. Kalaiyarasi, A. Stanley Raj  
257-264
- **Microplastic- An Imposing Commination to the Aquatic Ecosystem and its Removal Strategies in Wastewater Treatment Plants: A Systematic Review**  
Anirudh Modak, Shamayita Basu  
265-274
- **Climate Change Perspective: The Advantage and Disadvantage of COVID-19 Pandemic**  
Kyaw Than Oo, Moh Moh Zaw Thin  
275-291
- **Role of Isolates of Bacillus Species for Biodegradation of Multiple Contaminants**  
Jyoti Sarwan, Jagadeesh Chandra Bose K  
292-298
- **Pattu Weaving: A Sustainable Fabric Manufacturing Technique**  
Ankita Srivastava, Ankur Saxena  
299-305
- **A Review on Sustainable Eco-friendly Cutting Fluids**  
Viraja Deshpande, P N Jyothi  
306-320



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# Environmental Impacts of Automotive Air Conditioning System Maintenance Practices Embraced by Service Technicians in Niger State, Nigeria

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**Abstract:** This research work examined the environmental impacts of automotive air conditioning system maintenance practices embraced by service technicians in Niger State, Nigeria. The study sought out the problem associated with automotive air conditioning maintenance practices and the way of improving automotive air conditioning system maintenance practices by automotive air conditioning services technicians in Niger State. Two research questions and two hypotheses guided the study. A descriptive survey research designed was adopted for the study. A total population of 155 respondents comprises of 97 highly experienced registered air conditioning service technicians and 58 moderately experienced registered air conditioning service technicians in Niger State. The respondents were selected according to the year of service, which was 1-14 years for moderately experienced and 15 above for highly experienced service technicians. Due to manageable sizes of the respondents, the entire population was used i.e. no sampling techniques was utilized for the study. A structured questionnaire titled "Automotive Air Conditioning System Maintenance Practices Questionnaire" was face validated by three experts (one lecturer from Department of Industrial and Technology Education, Federal University of Technology Minna, one expert from Ministry of Environment Niger State and one expert from Ministry of Health Niger State). The questionnaire was pilot tested using 30 automotive air conditioning service technicians from Abuja. The data collected were analyzed using Cronbach Alpha Statistics and its yielded to 0.71 reliability coefficient. Mean and standard deviation were used to analyze the research questions and hypotheses were tested at 0.05 level of significance using z-test statistics. The numerical values obtained from the responses of the respondents were tabulated and analyzed using statistical package for social science (SPSS) version 23. The findings among other revealed that inhalation of concentration refrigerant vapour is dangerous and can be fatal, exposure to level of fluorocarbons above recommended exposure levels can results in loss of concentration and drowsiness, inhaling refrigerants adds to the effect of chronic illness. It is recommended amongst other that hazardous automotive air conditioning waste generated by automotive service technicians' shops should always be removed by licensed personnel under the supervision of environmental agencies. Manufacturer instructions on refrigerants should be followed by technicians.

**Keywords:** Automotive air conditioning, Environmental impact, Nigeria, Refrigerant, Service technicians

Conflicts of interest: None  
Supporting agencies: None

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## 1. Introduction

Automotive air conditioning system is a set of components that function together in order to emit coolness to a vehicle's interior. Nishant and Ekhlak (2018)

explained that automotive air conditioning is the process by which the air is cooled and cleaned, the humidity lowered and the air circulated. The quantity and quality of the air is also controlled. Under ideal conditions the air-conditioning system can be expected to accomplish all these tasks at the same time. The automotive air

conditioner in the context of this study functions as the mechanism to transfer heat from a vehicle to the surrounding. The automotive air-conditioning system works by manipulating refrigerant between a liquid and a gaseous state.

Most automotive air conditioning refrigerants are known to have negative effects on the environment since they contribute to global warming and ozone layer depletion. Greenhouse gases like carbon dioxide and emissions from some refrigerants contribute to global warming by absorbing infrared radiation and holding it in the atmosphere. Ogunleye et al. (2021) postulated that refrigerant is a fluid capable of changes of its state at low temperatures. Vandana and Gupta (2015) explained that natural refrigerants such as hydrocarbons, ammonia, and carbon dioxide have good thermodynamic fluids for a vapor compression system because they have large latent heats and have low pressure drops because of their properties. Refrigerant R-12 according to Adegun and Othman (2016) is ideal for automotive use because of its relatively low operating pressures, as compared to other refrigerants. The author further explained that R-12 does not react with most metals such as iron, aluminum, copper or steel, however, some refrigerant that appears to be toxic or flammable could be made useful for systems larger than a refrigerator, it is necessary to reduce their charge below the levels necessary to warrant a toxic or flammable situation in the case of a system leak (Mohan et al., 2019). Another constraint introduced with the reduction of charge in a system, is the maintaining of a base line thermal performance of the system including capacity, compressor power, and Coefficient of Performance (COP).

Refrigerant R-12 according to Vandana and Gupta (2015) argued that since tubes and components through which R-12 used in automotive air conditioning system passes through are made smaller, there is every tendency for capacity and COP to suffer due to a high pressure drop and this may result into a development of a technical problems of the entire system which may impact the environment negatively. Minimizing the environmental impacts of automotive air conditioning system can reduce harmful effects on the health, safety and productivity of staff, environmental prosecutions and fines, damage of business reputation, expensive clean-up costs and other business benefits which require the attention of a service technicians.

Service technicians are skilled workers that can operate in variety of industries to provide services and repairs. Ogunleye et al., (2021) postulated that service technicians are responsible for providing difference services, depending on their area of expertise, and diagnosing problems and making repairs. Service technicians in the context of this study are those individual that are responsible for the installation, maintenance, or repair of different units related to automotive air conditioning systems. The service technicians in the context of this study are further classified as highly experienced service technicians and moderately experienced service technicians, their year of service in the job is a major

factor considered for these classification. For instance, for those of them who have been in this job 1-14 years are termed moderately experienced and those with 15-25 years are termed highly experienced. Hence they are in better position to respond to the issues raised for this study. Automotive Air Conditioning (A/C) Service technicians have the potential of becoming sick, ill and disable for life because of their exposure to a variety of health hazards through pollution which can lead to skin cancers, cataracts, eyes problems, weakened immune systems. The automotive air conditioning servicing and repairing industry can play an important role in reducing pollution by ensuring that automotive air conditioning are operating efficiently and by extending air conditioning life through routine maintenance.

Maintenance is the action performed to keep machine or equipment functioning or in-service. Adeyemi (2017) defined maintenance practices as practices of high quality aimed at increasing machines performance with improved/enhanced functionality of parts using safe, secure technologies and methods utilizing optimal resources by reducing or eliminating machine downtime, Mean Time To Repair (MTTR) and products' wastes thereby providing maximum usability and reliability of parts / components, enhanced production benefits, economic impact and making the enterprise to stand competitively. Maintenance activities can influence the entire manufacturing/production operation, from product quality to on-time delivery records and its effect on the environment. Good maintenance practices in automotive air conditioning systems can cut production costs immensely, well beings of AC technicians and environment whereas poor maintenance procedures in air conditioning system leads to illness of technicians, affecting the environment and can also cost a company millions of naira to effect repairs and correct poor quality and production lost. In a bid to correct and reduce these menaces, it is on this basis that the study is designed to identify the environmental impacts of automotive air conditioning system maintenance practices embraced by service technicians in Niger State, Nigeria.

Automobile air conditioning maintenance practices protect the service technicians from over exposure to refrigerants, keep the environment clean and fresh, global warming as well as reduction in environmental pollution that may arise from haphazard handling of automotive air conditioning refrigerants. However, it has been observed by Adedokun and Audu (2019) that the rate at which mechanics handles waste is indecent, which also noticed by the researcher the manner at which air conditioning technicians handles and disposes refrigerants and other related wastes in Niger State is on the increase. Vandana and Gupta (2015) reported that many of these refrigerants are not only harmful and potentially life threatening but appears to be also flammable and should not be disposed indiscriminately because it increases the Ultraviolet (UV) Radiation in ozone layer.

A diminished ozone layer allows more radiation to reach the Earth's surface. For people, overexposure to UV rays can lead to skin cancer, cataracts, and weakened



... various factors... (The text is very faint and difficult to read, but appears to be an abstract or introduction.)

### 2.4 Strategies for effective management of automotive air conditioning and refrigeration handling and recycling

There are different strategies for effective management of automotive air conditioning and refrigeration handling and recycling which discussed by different researchers such as:

- 1. Selection of refrigerant
  - 2. Worker health and safety (Refrigeration, Air Conditioning and Pump Technical Update Committee, 2004)
  - 3. Selection of refrigerant
- Refrigerant selection is a balanced result of several factors that should be considered when selecting an alternative refrigerant to refrigeration air conditioning and heat pump systems are applications. The chosen solution will be a result of various system factors including suitability to the required use performance capacity and efficiency, safety including flammability and toxicity and economic cost refrigeration resources availability of the refrigerant, ease of use and ODP/GWP values change impact (climate change) and indirect energy source associated with production, maintenance, availability of refrigerant, health and safety, equipment and associated cost, skills and technology required to use, availability and safety and material compatibility.

The selection of a refrigerant for a given application must necessarily be a comparison of the above criteria where that one or more may ODP/GWP. The cost of the parameters will be studied all aspects are question to give a the optimum for each type of system and application. It particularly the various emissions include both the direct and indirect emissions contribution of the product over its lifetime (Refrigeration, Air Conditioning and Pump Technical Update Committee, 2004).

**Worker health and safety**

1. Manufacturing workers

Exposure to refrigerant vapours is also monitored by independent hygiene specialists and also by use of various workplace concentrations from air sampling performed by the manufacturer. It is essential to understand the requirements with the ODP/GWP. The ODP/GWP should also include information on the use of industrial sites and by professional workers (Refrigeration, Air Conditioning, 2004).

2. Refrigerant workers

Refrigerant workers have been evaluated for ODP/GWP and GWP/GWP. Studies have been conducted on alternative refrigerants with ODP/GWP as well as with 1 gas refrigerants and air safety. 1 gas refrigerants and air safety. Refrigerant workers must be refrigerant concentrations and safety requirements also need to be considered for worker health and safety by ODP/GWP refrigerants. Under both the ODP and 1 gas refrigeration in the EU, technicians need to undergo training and certification (Refrigeration, Air Conditioning, 2004).

3. Recycling and maintenance workers

Recycling and maintenance workers also need to undergo relevant 1 gas

## 1. Relevant Literature

### 1.1 ODP/GWP based health hazards

In the ODP/GWP based health hazards were classified (Refrigeration, Air Conditioning, 2004) with the basis of the health hazard is based on the ODP/GWP has the following procedure with effects to the atmosphere such as ozone gas depletion and climate change. It is essential to control ozone content effects to example destruction and destruction and application in outdoor space (United States Environmental Protection Agency, 2004).

### 1.1 Hydrofluorocarbon (HFC) based health hazards

HFC based health hazards health hazards is that of the new HFC substances. For example, HFC based HFC/GWP (Refrigeration, Air Conditioning, 2004) is based on the safety that there is being in application is high concentrations and contact with the respiratory system and cause irritation in majority of the HFC based HFC/GWP (Refrigeration, Air Conditioning, 2004) is also based on a procedure that a can contain an ozone depletion, a high concentration can cause an respiratory irritation and cause in application in confined spaces. These effects are listed in being common for many refrigerants (United States Environmental Protection Agency, 2004).

### 1.1 Hazards to human health

The effect of HFC's on human health has been studied and reported in the literature. Van (2005) reports that due to the physicochemical properties of HFC's there is low toxicity to human health. For example, for HFC's with a maximum level of 1000 ppm, there is no ODP/GWP (Observed Adverse Effect Level) and no (OEL) (Observed Adverse Effect Level). Exposure to HFC's is reported by Van to arise from the following activities:

- 1. Leaking a spills from the refrigeration system,
- 2. The electronic appliances recycling system, and
- 3. Charging and gas delivery operations (Van, 2005)



From consultation with a reclaimer, if the recovered refrigerant material is not suitable for re-processing, the material must be treated at an approved waste treatment facility.

### 3. Materials and methods

The study was conducted in all the motor vehicles workshops that house the automotive air conditioning service technicians in Niger State. Niger State is situated in the North-Central Geopolitical Zone of Nigeria with a total land mass of 86,000km<sup>2</sup>; approximately 8.6 million hectares constituting about 9.3% of the total land area of the country. Lying on latitude 3.200 East and longitude 11.300 North, the State shares a country border with the Republic of Benin (West) and State border within Nigeria, these include the Federal Republic Territory (FCT) on the South East, Zamfara (West), Kebbi (North West), Kwara (South West) and Kaduna (North East). The targeted population for the study was 155 respondents comprising of 97 highly experienced and 58 moderate experienced registered automotive air conditioning system service technicians in Niger State (NATA, 2021). Since the population was of manageable size, the entire population was study; hence no sampling technique was employed for the study. Mean and standard deviation were used to analyze the two research questions while z-test statistics was used to test the null hypotheses at 0.05 level of significance.

### 4. Results

Table 1 shows the mean responses of the respondents on the 18 items posed to determine the problems associated with automotive air conditioning maintenance practices with a grand mean of 4.63 which implies that the automotive service technicians highly embraced with the majority of items as problems associated with automotive air conditioning maintenance practices. The standard deviation of items ranges from 0.24 to 0.61. This standard deviation showed that the respondents were not too far from the mean and were closed in one another into their responses. This closeness of the responses adds values to the reliability of the item.

The analysis of the result of table 2 shows that the respondents embraced all items as regards to the ways of improving automotive air conditioning maintenance practices. This evident from the mean results which shows that the items indicated have their average mean not less than 3.50 and not more than 5.00. This implies that all items presented in the table are the ways of improving

automotive air Conditioning System Maintenance Practices in Niger State Nigeria and these were out of highly embraced. The Standard Deviation (SD) value of the 25 items in the table 4.6 ranges from 0.00 to 0.50, this signified that the respondents were closer to each other in their responses to the items.

**Hypothesis** There is no significant difference in the mean responses of highly experienced automotive air conditioning service technicians and moderately experienced automotive air conditioning service technicians on problems associated with the maintenance practice of automotive air conditioning.

Table 3 shows the z-test analysis of differences in the responses of Registered Highly Experienced Automotive Air Conditioning Service Technicians and Registered Moderately Experienced Automotive Air Conditioning Service Technicians in Niger State as regards the problem associated in the maintenance Practices of Automotive air Conditioning System. The table reveals that the probability value obtained was found to be 0.007 which is less than the probability value of 0.05 in comparison. The null hypothesis was therefore rejected. Therefore, there was significant difference in the mean responses of highly experienced automotive air conditioning service technicians and moderately experienced automotive air conditioning service technicians as regards the problem associated in the maintenance Practices of Automotive air Conditioning System in Niger State.

**Hypothesis:** There is no significant difference in the means responses of highly experienced automotive air conditioning service technicians and moderately experienced automotive air conditioning service technicians on ways of improving automotive air conditioning system maintenance practices.

Table 4 shows the z-test analysis of differences in the responses of Registered Highly Experienced Automotive Air Conditioning Service Technicians and Registered Moderately Experienced Automotive Air Conditioning Service Technicians in Niger State as regards the ways of improving automotive air Conditioning System Maintenance Practices. The table reveals that the probability value obtained was found to be 0.060 which is greater than the probability value of 0.05 in comparison. The null hypothesis was therefore accepted. Therefore, there was no significant difference in the mean responses of highly experienced automotive air conditioning service technicians and moderately experienced automotive air conditioning service technicians as regards the ways of improving automotive air Conditioning System Maintenance Practices in Niger State.

Table 1: Mean responses and standard deviation regarding the problems associated with automotive air conditioning system maintenance practices

S/N	Items	X <sub>1</sub>	SD <sub>1</sub>	Remark
	<b>Problem associated</b>			
1	Unskillful AC technicians causes faulty installation, poor service procedures and inadequate maintenance.			



1	Inhalation of concentration refrigerant vapour is dangerous and can be fatal	4.62	0.48	Highly Embraced
2	Exposure to level of fluorocarbons above recommended exposure levels can results in loss of concentration and drowsiness.	4.50	0.50	Highly Embraced
3	Improper handling and recycling leads to skin irritation, frostbite and serious eye irritation	4.41	0.50	Embraced
4	Improper handling and recycling of refrigerants leads breathing problem	4.53	0.51	Highly Embraced
5	Illness and constant fatigue are experienced when handling and recycling refrigerants	4.59	0.47	Highly Embraced
6	HFO blend R-448A at high concentration can cause irregular heartbeat to technicians	4.60	0.49	Highly Embraced
7	Inhaling refrigerants adds to the effects of chronic illness	4.75	0.39	Highly Embraced
8	Improper release affects terrestrial and aquatic ecosystem	4.76	0.43	Highly Embraced
9	Global warming is contributed to by the emission of manmade "greenhouse" gases as a result of handling and recycling refrigerants	4.43	0.61	Embraced
10	Global warming causes the temperature in the atmosphere to rise and has effect on climate	4.57	0.37	Highly Embraced
11	Direct exposure to HFO-1234yf, HCF-134a, and other refrigerants exposing to loss or reduce the life span of A/C technicians	4.79	0.44	Highly Embraced
12	Attempting to recycle impure or contaminated refrigerants can damage your refrigerant recovery and recycling system	4.59	0.49	Highly Embraced
13	When the filter in the air conditioning and refrigerating is inactive, it exposes the air conditioning and refrigerating user to risk	4.72	0.35	Highly Embraced
14	Different formulations could affect the performance of the refrigerant handling, recovery and recycling	4.57	0.49	Highly Embraced
15	Inhabitants in tropical and subtropical urban areas are at especial risk due to high population density, high temperatures.	4.69	<b>0.42</b>	<b>Highly Embraced</b>
16	Over exposure to ultraviolet (UV) Radiation can lead to skin cancer, cataracts and weakened immune systems	4.89	0.24	Highly Embraced
17	Ozone layer depletion allows more UV radiations which can also lead to reduction of crop yield, disruptions in the marine food chain and other harmful effects	4.82	0.25	Highly Embraced
18		4.53	0.50	Highly Embraced
	<b>Grand Total Mean/SD</b>	<b>4.63</b>	<b>0.44</b>	<b>Highly Embraced</b>

N= numbers of respondents, XT = mean of all respondents, SDT = average standard deviation. highly embraced (5), embraced (4), moderately embraced (3), not embraced (2) and undecided (1)

Table 2: Mean responses and standard deviation of respondents as regards the ways of improving automotive air conditioning system maintenance practices.

S.N.	Items	XT	SDT	Remark
1	The work area should be ventilated when dispersing vapour	4.63	0.48	Highly Embraced
2	Fan or blower should be use in confine area for the dispersion of vapour	4.49	0.50	Embraced
3	Available vapour or oxygen should be tested by refrigerant leakage detector or equipment for monitoring oxygen	4.42	0.49	Embraced

1	Technicians should follow certain precautions when working with refrigerants to ensure the safety of themselves and their customer	4.52	0.51	Highly Embraced
2	Government should make public enlightenment on the health implication of improper handling, recycling of refrigerants	4.58	0.47	Highly Embraced
3	Replacing refrigerants that are hazardous in native with the ones that are more environmentally friendly.	4.60	0.49	Highly Embraced
4	All refrigerant that cannot be recycled onsite must be collected and shipped to an authorized facilities for reclamation	4.75	0.40	Highly Embraced
5	Prohibiting the use of fluorinated greenhouse gases with a global warming potential higher than 150	4.75	0.43	Highly Embraced
6	Certification requirement for refrigerant evacuation to maximize recovery of Ozone depletion substances (ODS) during the disposal of refrigeration	4.42	0.62	Embraced
7	Before handling and recycling any refrigerants, personnel should be familiar with safety concerns for the specific product with which they are working	4.56	0.37	Highly Embraced
8	Always use with adequate ventilation to improve the circulation of oxygen	4.78	0.45	Highly Embraced
9	Ensure that there is pressure relief valve between valve to release trap liquid refrigerants	4.59	0.49	Highly Embraced
10	Use an alcohol spray to clean refrigerant sight glasses that have become coated with ice.	4.72	0.35	Highly Embraced
11	When leak testing a system, use nitrogen for increasing the pressure after the refrigerant is recovered.	4.58	0.49	Highly Embraced
12	Never use oxygen or compressed air for pressurization (some refrigerants may explode when under pressure and mixed air)	4.69	0.42	Highly Embraced
13	People affected from refrigerants	4.89	0.21	Highly Embraced
14	Overexposure should not be treat by Physicians using expinephrine.	4.82	0.25	Highly Embraced
15	Government should organize seminars on problem solving skills for scrap recyclers and technicians	4.54	0.49	Highly Embraced
16	Government should formulate a medical body that will be educating the technicians on handling and recycling of refrigerant at least twice in a year	5.00	0.00	Highly Embraced
17	Government should develop or strengthen air standard enforcement capacity	4.69	0.46	Highly Embraced
18	Government should improve monitoring of traditional and trace pollutant emissions and concentration.	4.74	0.25	Highly Embraced
19	Avoiding mixing refrigerants when refilling gases	4.57	0.49	Highly Embraced
20	Instilling disciplinary measures on problematic staffs or members should be care by their association	4.69	0.42	Highly Embraced
21	Putting measure in place to prevent problem from occurring by then association	4.89	0.21	Highly Embraced
22	Strengthen existing environmental guidelines and standards and develop new ones where necessary in order to counter the increasing level of emissions	4.82	0.25	Highly Embraced
23	Automotive refrigerants should not be vent into the air	4.67	0.40	Highly Embraced
24	<b>Grand Total Mean /SD</b>	<b>4.67</b>	<b>0.40</b>	<b>Highly Embraced</b>

Table 3: z-test analysis of significant difference in the mean responses of the respondents as regards the problem associated in the maintenance practices of automotive air conditioning

Automotive air conditioning service technicians	N	Mean	S.D	df	Z	P-value	Remark
Highly Experienced Service Technicians	97	4.65	0.11				



Moderately Experienced Technicians	Service	55	4.60	0.10	150	2.75	0.01	Rejected
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Table 4: Z-test analysis of significant difference in the mean responses of the respondents as regards the ways of improving automotive air conditioning system maintenance practices in Niger State

Automotive air conditioning service technicians	N	Mean	S.D	df	Z	P-value	Remark	
Highly Experienced Technicians	Service	97	4.68	0.10	150	1.89	0.06	Accepted
Moderately Experienced Technicians	Service	55	4.65	0.08				

### 5. Discussion

The Findings in Table 1 relating to research question 1 revealed that inhalation of concentration refrigerant vapour is dangerous and can be fatal, exposure to level of fluorocarbons above recommended exposure levels can result in loss of concentration and drowsiness, inhaling refrigerants adds to the effect of chronic illness. Refrigerants such as HFO blend R-448A, HFO-1234yf, HCF-134a etcetera are also listed as a possible skin or eyes irritant, can cause frostbite, at high concentrations can cause an irregular heartbeat and cause asphyxiation in confined spaces. These effects are listed as being common for many refrigerants (United State Environmental Protection Agency, 2014). Tsai, (2005) argued that exposure to HFCs such as leaks or spills from the refrigeration system exposure, the electronic appliance recycling system; and Cleaning and gas delivery pipelines affect the health of workers who works on the refrigeration system

The Findings in Table 2 relating to research question 2 showed that the respondents agreed good knowledge of potential hazards of chemicals in the shop and how to respond to spills, leaks and other emergencies; making sure chemicals including paints, solvents, and other toxic substances are not poured on the ground or waterways; replacing materials that are hazardous in nature with more environmentally alternatives; and storage of automotive liquid waste according to the manufacture's requirements are very essential. This is because the improperly handled chemicals used in automotive workshops can seriously affect human and the environment. In support of this assertion FETA (2015) reported that improperly managed automotive waste perpetuates and aggregates environmental and health challenges already being experienced by developing countries particularly Nigeria. The findings are also in agreement with Pennsylvania Department of Environmental Protection (PDEP)(2015) which reported that the impact of waste from automotive can be reduce if automotive industries should make minimum use of material that are non-hazardous through the application of more efficient technologies. The findings also revealed that government should make

public enlightenment on health implication of improper automotive waste disposal. This is in conformity with opinion of Warlito and Charlie (2015) who advocated that to avoid exposure to risk from automotive waste requires stringent management practices with adherence to safety standards in handling automotive waste particularly liquid waste. This shows that there is need to enlighten the automotive air conditioning systems especially automotive AC service technicians on the human and environmental health implications of indiscriminate disposal of automotive air conditioning waste.

### 6. Conclusion

The study determines the automotive air conditioning system maintenance practices embraced by service technicians in Niger State, Nigeria. The findings of the study revealed that the services technicians accepted that inhalation of concentration refrigerant vapour is dangerous and can be fatal to human health and environment. The improper handling and recycling of refrigerant increase Ultraviolet (UV) radiation in ozone layer. A diminished ozone layer allows more radiation to reach the Earth's surface. For people, overexposure to UV rays can lead to skin cancer, skin irritation, cataracts, and weakened immune systems. Increased UV radiation can also lead to reduced crop yield, disruptions in the marine food chain, and other harmful effects which affected the general environment. It was further concluded that ways of improving automotive air conditioning system maintenance practices such as the work area should be ventilated when dispersing vapour, fan or blower should be used in confine area for the dispersion of vapour, Strengthen existing environmental guidelines and standards and develop new ones where necessary in order to counter the increasing level of emissions, automotive refrigerants should not be vent into the air, to mention but a few required by automotive air conditioning service technicians to reduces the effect of refrigerants in the society. Therefore, this study has implication for government, regulatory bodies and Nigeria Automobile Technicians Association for inclusion of these identified automotive air conditioning system maintenance practices required by service technicians which no doubt will assist automotive air condition service technicians during





maintenance practices with a view to undertake the full safety, collection, disposal, recycling practices of automotive air conditioning systems in the automotive world of work.

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## References

- Adedokun D. & Audu R. (2019). Assessment of automobile waste management practices in Osun State, Nigeria. *International Journal of Engineering and Technology Research*, 17(5), 87-94.
- Adegun I.K & Obasa O.V. (2016). Development of a dual purpose refrigeration system for domestic use. *Nigerian Journal of Technology (NIJOTECH)*, 35(4), 814-824.
- Adeyeri, M.K. (2017). *Sustainable maintenance practices and skills for competitive production system*. Published by INTECH.
- ECHA. (2017). *HFO-1234ze substance information*. Available at: <https://echa.europa.eu/substanceinformation/substanceinfo/100.104.972>.
- FETA. (2015). *An introduction to A2L refrigerants and their use in refrigeration, air conditioning and heat pump applications*. Available at <http://www.refcom.org.uk/media/1202/an-introduction-to-a2l-refrigerants-final.pdf>
- Gluckman Consulting. (2016). *Information sheet 21: training and certification requirements for refrigeration, air-conditioning and heat pumps*. Available at <http://www.gluckmanconsulting.com/wp-content/uploads/2016/08/IS-21-Training-and-Certification-RACHP-v2.pdf>
- Martyn, S. (2019). *Descriptive research design*. <https://explorable.com/descriptive-research-design>
- Mohan, L., Ravinda K., & Deepak B. (2019). *Air conditioning and refrigeration*. Study material for XI & XII central board of secondary education skill development course, Delhi, India
- NPE. (2021). *Effect of air pollution Niger State*. Environmental Protection Agency (NISEPA)
- NATA. (2021). *Registered automobile air conditioning and refrigeration technicians in Niger State*.
- Nishant A., & Ekhlak K., (2018). Automotive air conditioning system. *International Research Journal of Engineering and Technology*, 76(3), 2121-2125.
- Ogunleye U.O., Audu, R., & Hassan A.M. (2021). *Automotive air conditioning system maintenance practices adopted by service technicians in Niger State*. Nigeria. Federal University of Technology, Minna Niger State.
- PDEP. (2015). *Proper management of wastes from automotive recycling operation*. <http://www.dep.slate.pa.us>
- RTOC. (2018). *Montreal protocol on substances that deplete the ozone layer*. UNEP Nairobi Kenya.
- Tsai, W.T. (2005). An overview of environmental hazards and exposure risk of hydrofluorocarbons (HFCs). *Chemosphere*, 61(1), 1539-1547.
- USEPA. (2014). *Protection of stratospheric ozone: Determination 29 for significant new alternatives policy program*.
- USEPA. (2018). *Protection of stratospheric ozone: Revision to the refrigerant management programs extension to substitutes*. The Daily Journal of the United States Government.
- Vandana, J. & Gupta R.C., (2015). Experimental investigation of domestic refrigerator with microchannel condenser using 134A and hydrocarbon refrigerant. *Global Journal of Engineering Science and Researches*, 2(5), 22-29.
- Warlito, G. & Charlie, C. (2015). *Development of an automobile liquid waste management system for the BSU-CIT Automobile Technology Department*. Scientific Research, 02, 1-8.



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