problem. Ribbens (2003), noted that the use of scan tools like On-Board Diagnostic, One, Two and Three (OBDI, OBDII, and OBDIII) are commonly available only manufacturer's approved service centres today. This may be due to the fact that most motor vehicle mechanics are not financial buoyant enough to afford the machine in addition to the fact that they lack the prerequisite skills required for its usage. This has led to more damage of automotive because despite the use of diagnostic scan tools by some of these motor vehicle mechanics, there seems to be a large element of misdiagnosis or failure to adequately pinpoint the real source of particular vehicle problems. This ends up leaving the vehicle worse than it was brought for maintenance in most cases because more damages are caused when trial by error is used. It is against this backdrop that this study intends to identify the core on-board diagnostic (OBD) skills required by motor vehicle mechanics for troubleshooting engine performance and transmission system of modern automotive in Niger State.

Method

Descriptive survey research design is adopted for this study. According to Kennedy and Kepha (2015), descriptive research specifically deploys a cross-sectional survey to gather information from different groups of people who share common characteristics such as socio-economic status, educational background among others but differ in variable area of interest. This design is suitable for this study because the study is aimed at seeking the opinion of motor vehicle mechanics master craftsmen and lecturers about OBD skills required for troubleshooting modern automotive in Niger State. The study was carried out in the three zones of Niger State. The total population was 8367 which comprises of 8338 of Motor Vehicle Mechanic Master Craftsmen and 29 Automobile Technology Lecturers from higher institutions offering automobile technology in Niger State. Simple proportionate random sampling was used to draw out 833 motor vehicle mechanics master craftsmen shown in Table 1 below while there was no sampling done for the lecturers since their population is relatively manageable.

Table 1: Sample Distribution of the Population of Motor Vehicle Mechanics Master Craftsmen

S/N	Zones	Motor vehicle mechanics master craftsmen
1.	Zone A	265
2.	Zone B	352
3.	Zone C	216
	Total	**833**

The instrument that was used for data collection was a structured questionnaire titled: Motor Vehicle Mechanics' On Board Diagnostic Skill Questionnaire (MVMOBDSQ). The questionnaire contains 40 on board diagnostic skills, developed after a review of literatures within the reach of the researcher and expert opinion from notable automobile maintenance workshops. The questionnaire was designed with response options: Highly Required (4), Required (3), Moderately Required (2) Not Required (1). The instrument was divided into two sections (Sections 1 and 2). Section 1: consists of personal information of the motor vehicle mechanics master craftsmen and automobile technology lecturers. Section 2 comprises of two (2) subsections (A and B): Section A: focuses on board diagnostic skills required for troubleshooting engine performance of modern automotive and it contains 20 items, while Section B deals with on-board diagnostic skills for troubleshooting transmission system containing 20 items. The instrument was validated by three experts. The internal consistency was determined using Cronbach Alpha and a coefficient of 0.84 was obtained. A total of 862 questionnaires were distributed and a total of 807 was returned representing 94%. The data collected for the study was analysed using Mean and Standard Deviation to answer the research questions, while z-test statistics was used to test the hypotheses at 0.05 level of significance using Statistics Package for Social Sciences (SPSS 23). The decision for each research question was based on the resulting mean scores interpreted relative to the concept of the real lower and upper limit of numbers shown in Table 2 Similarly, decision on hypotheses formulated for the study was based on comparing the significant value with ($p<0.05$) level of significance. That is, where the significant value is less than ($p<0.05$), the null hypothesis will be rejected, while when it equals or is greater than ($p\geq0.05$) level of significance, it will be upheld.

Table 2: Decision Rule

S/N	Response Mode	Rate	Reg/Limit	Decision
1.	Highly Required	4	3.50 – 4.49	Highly Required
2.	Required	3	2.50 – 3.49	Required
3.	Moderately Required	2	1.50 – 2.49	Moderately Required
4.	Not Required	1	0.50 – 1.40	Not Required

Results

Research Question 1

What are the on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the engine performance of modern automotive?

Table 3: Mean and Standard Deviation of Responses of Respondents on the on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the engine performance of modern automotive $N1 = 778, N2 = 29$

S/No	ITEM	$\bar{x}_{av}$	SD_{av}	Remark
1.	Ability to use the diagnostic scan tool Monitor the variable camshaft timing (VCT) circuit to the PCM for high and low voltage	3.24	0.77	Required
2.	Ability to monitor camshaft timing using diagnostic scan tool	3.23	0.77	Required
3.	Ability to check the variable camshaft timing (VCT) position for a misalignment using the scan tool	3.23	0.69	Required
4.	Using the scan tool to check if the oxygen sensor signal response for a fuel shift corresponds to the correct engine bank	3.14	0.80	Required
5.	Monitor vehicle operation rationality check with the aid of a scan tool	3.09	0.72	Required
6.	Ability to check the Mass Airflow (MAF) sensor signal using a scan tool	3.13	0.71	Required
7.	Use the scan tool to monitor the powertrain control module (PCM) for low air flow (or voltage)	3.19	0.61	Required
8.	Ability to check the MAF sensor tube for air leaks using the scan tool.	3.22	0.70	Required
9.	Checking the functionality of Manifold Absolute Pressure (MAP) using scan tool	3.09	0.69	Required
10	Monitoring the live date of Engine Coolant Temperature (ECT) on a scan tool	3.11	0.76	Required
11	Use the scan tool to monitor the throttle position (TP) sensor circuit for a non-closed throttle position at idle.	3.20	0.69	Required
12	Checking the cylinder heat temperature (CHT) for voltage variations	3.21	0.70	Required
13	Testing the Intake Air Temperature (IAT) sensor for detected temperature variation.	3.08	0.77	Required
14	Ability to check the Turbocharger/Supercharger Inlet Pressure Sensor for voltage fluctuation.	3.12	0.66	Required
15	Using the scan tool to read heated oxygen sensor (HO2S) heaters for open and short circuits.	3.18	0.69	Required

16	Ability to run diagnosis on the adaptive fuel strategy and fuel delivery hardware to detect and rectify air/fuel ratio imbalances	3.17	0.75	Required
17	Using the scan tool to ascertain if the Fuel Temperature Sensor reading falls within calibrated limit.	3.20	0.62	Required
18	Checking the Engine Oil Temperature (EOT) Sensor reading for voltage fluctuation	3.20	0.71	Required
19	Ability to test the comprehensive component monitor (CCM) for faults	3.04	0.60	Required
20	Ability to check the powertrain control module (PCM) excessive engine RPM in neutral or operated in the wrong transmission.	3.24	0.67	Required

$\bar{x}_{av} = Mean\ Average, \qquad SD_{av} = Standard\ Deviation\ Average$

The result above shows that the mean of all the 20 items falls within the range of 3.04 and 3.24 while the standard deviation lies within a positive value of 0.60 and 0.80, indicating that all the 20 items are considered as OBD skills that are required by motor vehicle mechanics for effective troubleshooting of the engine performance of modern automotive.

Research Question 2

What are the on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the transmission system of modern automotive?

Table 4: Mean and Standard Deviation of Responses of Respondents on the on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the transmission system of modern automotive $N1 = 778, N2 = 29$

S/No	ITEM	$\bar{x}_{av}$	SD_{av}	Remark
1.	Ability to diagnose voltage fluctuation in the Clutch Switch Input Circuit	3.21	0.71	Required
2.	Using the scan tool to test for voltage fluctuation in the Transmission Range Sensor	3.12	0.59	Required
3.	Ability to check the Actuator Supply Voltage circuit for any interruption in transmission solenoid	3.25	0.61	Required

4.	Ability to detect open or short circuit and possible voltage fluctuations in the Output Shaft Speed (OSS) Sensor	3.35	0.63	Required
5.	Using the scan tool to identify possible cause of clutch pedal position switch trouble	3.15	0.83	Required
6.	Using the scan tool to test the Park/Neutral Position (PNP) switch for functionality	3.19	0.75	Required
7.	Ability to test for functionality and appropriateness of 4x4L when the switch is cycled on and off	3.35	0.67	Required
8.	Checking output shaft speed (OSS) sensor for irregular or interrupted rotation of the transmission output shaft	3.09	0.72	Required
9.	Using the scan tool to diagnose intermittent malfunction signal in the Turbine Shaft Speed (TSS) Sensor	3.25	0.57	Required
10	Testing Transmission Fluid Pressure to determine if it meet the minimum calibrated value	3.13	0.63	Required
11	Ability to monitor signals from Park / Neutral Switch Input Circuit to ensure it is within minimum calibrated value	3.25	0.71	Required
12	Using the scan tool to Test the circuit signal of the TCM communication circuit to ensure it is within calibrated value	3.12	0.76	Required
13	Ability to diagnose the cause of Torque Converter Clutch Circuit Malfunction	3.32	0.66	Required
14	Ability to monitor live data reading of Clutch Pedal Switch Circuit to ensure it is within the calibrated value	3.19	0.63	Required
15	Using the scan tool to Diagnose possible cause of gear Shift Malfunction	3.23	0.60	Required
16	Ability to diagnose Transmission Control System Malfunction and clear the freeze data from the ECU	3.07	0.65	Required
17	Using the scan tool to diagnose Incorrect Gear Ratio	3.17	0.66	Required
18	Ability to calibrate newly mounted gear box and other power train components	3.04	0.66	Required

19	Using the scan tool to monitor the Engine Speed Input Circuit to ensure the signal is within calibrated value	3.16	0.76	Required
20	Ability to retrieve and clear transmission system freeze data in the ECU	3.28	0.58	Required

$\bar{x}_{av} = Mean\ Average, \qquad SD_{av} = Standard\ Deviation\ Average$

The result shows that the mean of all the 20 items falls within the range of 3.04 and 3.35 while the standard deviation lies within a positive value of 0.57 and 0.83, indicating that all the 20 items are considered as OBD skills that are required by motor vehicle mechanics for effective troubleshooting of the transmission system of modern automotive.

Hypothesis 1

There will be no significant difference in the mean response of motor vehicle mechanics master craftsmen and automobile lecturers on on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the engine performance of modern automotive.

Table 5: The z-test analysis of Responses of Respondents on the on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the engine performance of modern automotive $N1 = 778, N2 = 29$

Hartley test for equal variance						95.0% Confidence Intervals for Difference	
	Mean Diff.	Std. Error Diff.	t	df	Sig. (2-tailed)	Lower Limit	Upper Limit
Equal variances assumed	-.030	.131	-.230	805.000	.819	-.286	.226
Equal variances not assumed	-.030	.136	-.221	29.949	.827	-.296	.236

The result presented in the table above shows that the probability value calculated is greater than 0.05. Therefore, the null hypothesis is upheld.

Hypothesis 2

There will be no significant difference in the mean response of motor vehicle mechanics master craftsmen and automobile lecturers on on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the transmission system of modern automotive.

Table 6: The z-test analysis of Responses of Respondents on the on-board diagnostics skills required by motor vehicle mechanics for troubleshooting the transmission system of modern automotive $N1 = 778, N2 = 29$

Hartley test for equal variance						95.0% Confidence Intervals for Difference	
	Mean Diff.	Std. Error Diff.	t	df	Sig. (2-tailed)	Lower Limit	Upper Limit
Equal variances assumed	-.110	.128	-.857	805.000	.392	-.362	.142
Equal variances not assumed	-.110	.123	-.893	30.329	.379	-.351	.131

The result presented in the table above shows that the probability value calculated is greater than 0.05. Therefore, the null hypothesis is upheld.

Discussion of Results

The results emanating from the of respondents' responses to research question one and hypothesis one as presented in Table 3 and Table 6 respectively revealed that the 20 skills itemised are required for effective troubleshooting of engine performance of modern automotive because the mean and probability value calculated are above the set values of 2.5 and p>0.05 respectively. Some of these skills among others include; ability to use the diagnostic scan tool to check the variable camshaft timing (VCT) circuit to the PCM for high and low voltage, ability to monitor camshaft timing using diagnostic scan tool, ability to check the variable camshaft timing (VCT) position for a misalignment using the scan tool, using the scan tool to check if the oxygen sensor signal response for a fuel shift corresponds to the correct engine bank, monitor vehicle operation rationality check with the aid of a scan tool, ability to check the Mass Airflow (MAF) sensor signal using a scan tool, using the scan tool to monitor the powertrain control module (PCM) for low air flow (or voltage), using the scan tool to read heated oxygen sensor (HO_2S) heaters for open and short circuits, Monitoring the live data of Engine Coolant Temperature (ECT) on a scan tool, using the scan tool to

ascertain if the Fuel Temperature Sensor reading falls within calibrated limit, ability to check the comprehensive component monitor (CCM) for faults, checking the functionality of Manifold Absolute Pressure (MAP) using scan tool.

The synergy between the opinion of both motor vehicle mechanics master craftsmen and automobile lecturers is an indication that both parties agree to the fact that modern automotive are now computerised and have to be electronically troubleshot using OBD and other technologies for better efficiency. This finding is in conformity with the findings of Udogu (2015), who opined that motor vehicle mechanic work graduates of various technical colleges require OBD skills in the maintenance of engine, ignition, fuel, transmission and braking system of vehicles brought to their respective workshops because of the technologies that drives such automobile systems. This view also supported by Yavala (2010), who stated that graduates of motor vehicle mechanics practice from technical colleges need improvement in work skills for engine maintenance, steering and braking system and auto electricity in order to be employed in the automotive maintenance industry since most systems and sub systems of modern automotive are primarily controlled by computerised systems, else loss their source of income.

Results from research question two revealed that all the items suggested were agreed by both group of respondents as skills required for effective troubleshooting of transmission system of modern automotive. The convergent view of motor vehicle mechanics master craftsmen is further reinforced by the result presented in Table 6 which shows that there was no significant difference in the response of both groups of respondents. Some of the skills agreed by both parties among others include; ability to diagnose voltage fluctuation in the Clutch Switch Input Circuit, using the scan tool to test for voltage fluctuation in the Transmission Range Sensor (TRS), ability to check the Actuator Supply Voltage circuit for any interruption in transmission solenoid, ability to detect open or short circuit and possible voltage fluctuations in the Output Shaft Speed (OSS) Sensor, using the scan tool to identify possible cause of clutch pedal position switch trouble, using the scan tool to test the Park/Neutral Position (PNP) switch for functionality, checking output shaft speed (OSS) sensor for irregular or interrupted rotation of the transmission output shaft, using the scan tool to diagnose intermittent malfunction signal in the Turbine Shaft Speed (TSS) Sensor.

This finding above is in agreement with Jittiwut (2010) and Robert (2004), which was established that the operation of vehicle electronic and software control systems operates on a number of different levels. Therefore, troubleshooting procedure should be carried out in this order starting from individual entity down to network level by taking readings from the individual sensor and comparing readings with the calibrated value in order to accurately troubleshoot the fault.

Conclusion

Motor vehicle mechanics in Niger state need on board diagnostic skills to enable them effectively troubleshoot the modern automotive trouping into the state from the Federal Capital Territory (FCT) and other neighbouring states. This will enable them to be able to discharge their duties effectively and efficiently as well as remain relevant in the 21st century. It is against this backdrop that this study was designed to identify the core on-board diagnostic (OBD) skills required by motor vehicle mechanics for troubleshooting engine performance and transmission system of modern automotive in Niger State.

Recommendations

1. All the skills identified in this study be included in the training given to motor vehicle mechanics apprentices in Niger State.
2. The state government should come to the aid of the motor vehicle mechanics by providing funds to enable them undertake the training as well as procure OBD scan tool.

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ASSESSMENT OF AUTOMOBILE WASTE MANAGEMENT PRACTICES IN OSUN STATE, NIGERIA

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Abstract

The purpose of the study was to assess automobile waste management practices in Osun State, Nigeria. The study answered two research questions and two null hypotheses were formulated and tested at 0.05 level of significance. Descriptive survey research design was adopted for the study and population for the study was 388 respondents comprised of 208 registered automobile mechanics master craftsmen and 180 officials of all waste management regulatory agencies in Osun State. A structured questionnaire which contains 37 items designed to obtain information from the respondents. The data collected were analyzed using mean, standard deviation, and z-test statistics was used to test the null hypotheses 1 and 2. Based on the data analyzed, the following findings among others revealed that hazardous automobile waste are not usually stored in closed containers neither collected by licensed agencies, used refrigerants from vehicle are not collected in approved recovery equipment for off-site reclamation, the used oils generated from mechanics workshop are disposed around their workshop to control dust and weeds, battery charger discharge used acid anywhere around their shop. Based on the findings of the study, the following recommendations were made: environmental agencies should introduce public enlightenment and education on the consequences of indiscriminate disposal of automobile wastes, periodical monitoring and assessment of automobile waste management by environmental agencies should be conducted as stipulated by law, and shops alleged for environmental pollution be sanctioned.

Keywords: *Assessment, Automobile, Waste, Management*

Introduction

The importance of automobile in the economic and social development of any nation cannot be overemphasized. Automobile have affected all aspects of society, such as economy and environment; it directly contributed to the wellbeing of people through their use for the transportation of persons, goods and services from one place to another for personal or business activities (Qiksearch, 2017). It is therefore very unfortunate

to note that while automobiles enhanced our lives, they also contributed to the growing global problem of waste management. SmallstarterThinktank (2013) however reported that Nigeria is the primary destination for used vehicles, used engines and other used automobile spare parts ultimately resulting in automobile wastes.

Waste is any solid, liquid, gaseous, discarded material that has ceased to be of any value and potentially to be disposed (Hoornweg and Bhada -Tata, 2012). Therefore, the waste that is generated and obtained from automobile is called automobile waste. This is a generic term embracing what is made of automobile which include various forms of metal, polymer composite and plastics, fluids and lubricant, rubber, glass, textiles and other miscellaneous materials as well, that have ceased to be serviceable or ready for disposal (Kellogg, 2016). Automobile waste may be considered hazardous based on the following characteristics: ignitability, reactivity, corrosivity and toxicity (Hazardous Waste Expert, 2017). The waste from automobile can be broadly categorized as solid waste, liquid waste and gaseous waste. Solid waste in automobile includes plastics, rubbers, batteries, metals, wood, glass, cables and tyres. Liquid waste is related to petrol, diesel, and grease, cleaning solvents, acids from batteries, wastewater, and anti-freeze. Freon and combustion emission (Carbon monoxide (Co) constitute gaseous waste. These wastes are potentially dangerous to human health and the environment (World Bank, 2012). Classically, automobile wastes are generated from the following sources among others: automobile mechanic workshops and garages; vehicle users; automobile dealers; automobile industries. These include scrap components, liquid and gaseous substances and other miscellaneous materials. These wastes containing heavy metals and other environmental toxins that causing environment pollution and greenhouse gas emissions which contribute to climate change (Utamge *etal.*, 2013). Therefore an effective waste management practices needed to be adopted.

Waste management is knowledge about waste and its management which is premised on the prevention of waste from causing harm to human and environmental health (Research Gate, 2014a). In that respect, automobile waste management in the opinion of PR Newswire (2015); Abdhalah *etal* (2016) is the planning, financing and implementation of programmes for automobile waste collection and transportation, treatment, resource recovery (recycling), and final disposal back with regulations in sound environmentally sustainable best practices. Effective and sustainable automobile waste management therefore requires adherence to set standards at every stages of the management practices (World Health Organisation, 2014). This in consequence will impact positively ineffective of automobile waste management practices in Nigeria, especially in Osun State.

Waste management practices are those activities and actions required to manage waste from its inception to its final disposal. However, waste management practices

identified by Davidson (2011) include: collection practices; disposal practices; recycling practices. Other practices in waste management acknowledged by Uwadiegwa and Chukwu (2013) are waste management regulations and strategies for its effectiveness. Consequently, one of the biggest challenges in establishing an effective and efficient automobile waste management system in Nigeria is modern and sustainable collection practices.

Waste collection in waste management practices involves the transfer of waste materials (recyclables and non-recyclables) from the source of generation either for recycling purposes or final disposal. Cal Poly Pomona (n.d) described automobile waste collection as the emptying and transfer of different forms of waste (solid, liquid and gases) generated from various activities with automobile for recycling, reuse, energy recovery or ultimate disposal. This practice is influenced by the activities of scrap merchant and waste scavengers', number of collection points, waste quantity, storage capacity, costs of collection vehicles and distance to recycling plant, and disposal facilities (Das & Bhattacharyya, 2015). Improper collection and storage of fluid, used parts, tyres and wrecked vehicles is noted to cause environmental pollution (Cossu, 2013; Sharma *etal*, 2016). Therefore an explanation to effective automobile waste management practices is to reduce waste build-up, provide for collection equipment and facilities, and provide for waste treatment and adopt right disposal practices.

Waste disposal is significant and critical aspect in waste management practices and environmental issues. Cherdsaturkul (2012) described waste disposal as the final process whereby the ultimate wastes that have no further use to the society hit the land. In this regard the position of disposal practices in automobile waste management system cannot be overemphasised. These practices constitute those activities associated with ultimate removal of automobile waste which include collection and transportation directly to a landfill site when all form of diversion; reuse and volarisation are exhausted (Cossu, 2013; Ritzkowski & Stegmann, 2013). It is a practice at the final stage of the entire waste management practices. An improperly disposed automobile wastes is confirmed causing environmental and soil pollution, and ground water contamination (Jonathan and Elaine, 2012). It is therefore necessary to assess the management of automobile waste holistically.

Assessment as described by Coulshed and Orme (2012) is the systematic and participatory process that seeks to understand situation and set a basis for planning how change or improvement can be achieved. Therefore, assessment in the context of automobile waste management practices is the measurement for effectiveness of the management practices with aim of improving the current collection and disposal practices. However, most states in Nigeria and indeed Osun State generate automobile waste at an alarming rate specifically, by the automobile mechanics during engine

reconditioning, over hauling and servicing. The different types of automobile waste produce are noted not being properly managed the reason which may be due to lack of effective waste management practices. Therefore, the study is designed to assessment of automobile waste management practices in Osun State, Nigeria.

Research Questions

1. What are the collection practices of automobile waste management in Osun State, Nigeria?
2. What are the disposal practices of automobile waste management in Osun State, Nigeria?

Methodology

Descriptive survey research design was adopted for the study. The study was carried out in Osun State. The population for the study was 388 respondents comprised of 208 registered automobile mechanics master craftsmen and 180 officials of all waste management regulatory agencies in Osun State. A structured questionnaire was the instrument for data collection. The instrument was face and content validated by two experts, one from the Department of Industrial and Technology Education Automobile Technology Option, Federal University of Technology Minna Niger State and the other from Osun Waste Management Agency. T o determine the ability of the instrument, it was pilot-tested on 30 respondents in Ibadan, Oyo State that was not part of the study. Cronbach alpha was used to determine internal consistency of the instrument and it yielded a reliability coefficient of 0.84. Thus the instrument was considered appropriate for use by the researcher. The questionnaire was administered by the researcher with the help of five research assistants and 347 instruments were retrieved and analysed. A four (4) rating scale was used in the study from Strongly Agree (SA) – 4 points to Strongly Disagree (SD) – 1 point. The decision rule was based on the theory of true limit class limits of numbers with numerical values:

4 Strongly Agreed (SA)	3.50-4.00
3 Agreed (A)	2.50-3.49
2 Disagreed (D)	1.50-2.49
1 Strongly Disagreed (SD)	0.50-1.49

Therefore, the mean responses of the respondents were interpreted based on the true limits of numbers as highlighted above. The data collected from the study were analysed using Mean and Standard Deviation. The two null hypotheses were tested using z-test at 0.05 level of confidence.

Results

Research Question 1

What are the collection practices of automobile waste management in Osun State, Nigeria?

Table 1: Mean Responses of Registered Automobile Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State as regards the Collection Practices of Automobile Waste Management
N1 = 187, N2 = 160

S/N	Statements	X_1	X_2	X_T	SD_1	SD_2	SD_T	Decision
1.	Oil rags are placed in a sealed container for ease of collection	2.10	2.10	2.10	.540	.491	.516	Disagree
2.	Hazardous automobile waste are usually stored in closed containers for collection by licensed agencies	2.06	2.02	2.04	.499	.455	.477	Disagree
3.	Used solvent are kept in sealed drums for collection	2.01	1.98	2.00	.475	.427	.451	Disagree
4.	Used oil filters are crushed for collection by metal recycler	2.09	2.02	2.05	.642	.495	.568	Disagree
5.	Waste oils are stored in separate drums for collection	2.10	2.07	2.09	.609	.339	.474	Disagree
6.	Only metallic scraps of automobile waste are collected by waste pickers	2.71	2.88	2.79	.779	.830	.804	Agree
7.	There are modern waste collection facilities for automobile waste in all the local governments	2.04	2.02	2.03	.399	.507	.453	Disagree
8.	Registered private waste collectors provide services for the collection of automobile waste	2.01	2.04	2.02	.352	.474	.413	Disagree

9.	Informal waste pickers collect metallic scraps of automobile waste from mechanic shops, vehicle users and dump sites	2.51	3.00	2.76	.870	.449	.659	Agree
10.	There is curbside used oil collection programme for oil recycling incentives.	1.95	2.08	2.02	.378	.448	.413	Disagree
11.	Waste antifreeze is stored in separate closed container for collection	2.07	2.06	2.07	.446	.383	.415	Disagree
12.	Catalytic converters are taken to a catalytic converter collection centres for profit	2.13	2.15	2.14	.543	.540	.542	Disagree
13.	Bad batteries are stored separately from other flammable hazardous chemical for collection by recycler	2.12	2.26	2.19	.631	.596	.614	Disagree
14.	Drip pans are kept under stored vehicles with oil leaks for collection during repair work	3.08	3.14	3.11	.630	.345	.488	Strongly Agree
15.	Used refrigerants from vehicle are collected in approved recovery equipment for off-site reclamation	2.06	2.10	2.08	.588	.451	.520	Disagree
16.	Used tyres are collected for landfilling	2.13	2.14	2.13	.582	.469	.525	Disagree
17.	Punctured and emptied aerosol cans are stored in a container for ease of collection by scrap merchants	2.11	2.18	2.14	.558	.525	.541	Disagree

18.	Metals such a lead, copper, aluminum and steel are stored in a secure container for collection by a metal recycler.	2.07	2.21	2.14	.492	.587	.539	Disagree

Key

N_1, N_2, N_T = Numbers of Registered Automobile Mechanics Master Craftsmen, Officials of all the Waste Management Regulatory Agencies in Osun State and Total Numbers of Respondents

X_1 = Mean of Registered Automobile Mechanics Master Craftsmen

X_2 = Mean of Officials of all the Waste Management Regulatory Agencies in Osun State

X_T = Mean of All Respondents

SD_1 = Standard Deviation of Registered Automobile Mechanics Master Craftsmen

SD_2 = Standard Deviation of Officials of all the Waste Management Regulatory Agencies in Osun State

SD_T = Average Standard Deviation

Table 1 above presents the results on collection practices of automobile waste management in Osun State, Nigeria. The results revealed that Registered Automobile Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State agreed that only three items which are items 4, 8 and 16 are the major ways by which automobile wastes are being collected in Osun State, Nigeria. This implies that other items suggested are not widely practised within the state understudied. The average standard deviation ranges from 0.26 to 0.81 which inferred that the respondents were closer to each other in their responses to the items.

Research Question 2

What are the disposal practices of automobile waste management in Osun State, Nigeria?

Table 2: Mean Responses of Registered Automobile Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State as regards the Disposal Practices of Automobile Waste Management
N1 = 187, N2 = 160

S/N	Statements	X_1	X_2	X_T	SD_1	SD_2	SD_T	Decision
1.	Automobile waste dumping sites around the workshop are demarcated for disposal	2.03	2.08	2.05	.394	.308	.351	Disagree
2.	Used oil drained into drip pans are disposed into waste oil drum or tank separately	2.24	2.21	2.23	.578	.506	.542	Disagree
3.	Waste antifreeze is discharged into land rivers/streams/drains/canals for disposal	3.02	3.11	3.06	.523	.309	.416	Strongly Agree
4.	Used oil filters are punctured, drained and crushed for disposal	2.11	2.26	2.18	.427	.619	.523	Disagree
5.	Mechanics workshops do not have sink drain for wastewater	2.94	3.07	3.00	.525	.357	.441	Strongly Agree
6.	Used oils generated from mechanics workshop are disposed around their workshop to control dust and weeds	3.04	3.13	3.09	.271	.490	.381	Strongly Agree
7.	There are public landfills for disposing automobile waste	2.00	2.04	2.02	.207	.361	.284	Disagree
8.	Automobile wastes such as plastics, used tyres, rags or absorbents are disposed through burning	3.06	3.23	3.15	.246	.423	.334	Strongly Agree
9.	Battery charger discharge used acid anywhere around their shop	3.00	3.03	3.01	.180	.404	.292	Strongly Agree
10.	Vehicle air conditioning refrigerants are discharged into the air	3.02	2.85	2.93	.264	.702	.483	Agree

11.	Automobile wastes such as polymer bumper, glass, dash board, seat foam and clothing are disposed with domestic waste	3.03	3.10	3.06	.242	.540	.391	Strongly Agree
12.	Automobile mechanics workshop, vehicle users, dealers, and automobile industries are responsible for their wastes disposal	3.01	3.09	3.05	.320	.511	.416	Strongly Agree
13.	Used oils are discharged to the ground, sewers, drainage, ditches, septic tanks or streams.	3.04	3.08	3.06	.190	.413	.302	Strongly Agree
14.	Used motor oils are exchange for new oil from refinery agents at reduced price for disposal	2.02	2.14	2.08	.206	.402	.304	Disagree
15.	Used oils are burnt for fuel.	2.11	2.43	2.27	.333	.522	.427	Disagree
16.	Lead wheel (tyre) weight unused are returned to supplier and not put in dumpster	2.04	2.16	2.10	.290	.496	.393	Disagree
17.	Undeployed airbags are sold for reuse.	2.03	2.08	2.06	.372	.560	.466	Disagree
18	Catalytic converters are specially sell to core buyers	2.05	2.13	2.09	.288	.445	.367	Disagree
19	Used batteries are disposed in a trash	2.04	2.11	2.07	.334	.521	.428	Disagree

Key

N_1, N_2, N_T = Numbers of Registered Automobile Mechanics Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State and Total Respondents

X_1 = Mean of Registered Automobile Mechanics Master Craftsmen

X_2 = Mean of Officials of all the Waste Management Regulatory Agencies in Osun State

X_T = Mean of All Respondents

SD_1 = Standard Deviation of Registered Automobile Mechanics Master Craftsmen
SD_2 = Standard Deviation of Officials of all the Waste Management Regulatory Agencies in Osun State
SD_T = Average Mean of Standard Deviation

The result of analysis as presented in Table 2 on the disposal practices of automobile waste management in Osun State, Nigeria showed that the respondent disagree with items 1, 2, 4, 7, 14, 15, and 16 as well as items 17, and 18 as regards the disposal practice adopted in managing automobile waste. This is evident from the mean results which shows that all the items indicated have their average mean not less than 1.50 and not more than 2.49. This implies that other items presented in the table are the disposal practice of automobile waste adopted in Osun State, Nigreia. A grand average showed a standard deviation (SD) of 0.308 to 0.702 indicating that the respondents are not too far from the mean and not from one another in their responses.

Hypothesis One
There is no significant difference in the mean responses between registered automobile master craftsmen and officials of all the waste management regulatory agencies in Osun State as regards the collection practices of automobile waste management in Osun State, Nigeria

Table 3: z-test analysis of significant difference in the mean responses between registered automobile master craftsmen and officials of all the waste management regulatory agencies in Osun State as regards the collection practices of automobile waste management in Osun State

N1 = 187, N2 = 160

	Hartley Test for Equal Variance		z-test for Equality of Means						
	F	**Sig.**	**Mean Diff.**	**Std. Error Diff.**	**Z**	**Df**	**Sig. (2-tailed)**	**95% Confidence Interval for Difference**	
								Lower	**Upper**

Equal variances assumed	1.31	0.04	-.060	.057	-1.053	345	.293	-.172	.052
Equal variances not assumed			-.060	.056	-1.064		.288	-.171	.051

Table 3 shows the z-test analysis of differences in the responses of Registered Automobile Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State as regards the Collection Practices of Automobile Waste Management. The table reveals that the probability value obtained was found to be 0.288 which is greater than the probability value of 0.05 in comparison. The null hypothesis was therefore accepted. Therefore, there is no significant difference in the mean responses of Registered Automobile Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State as regards the Collection Practices of Automobile Waste Management in Osun State.

Hypothesis Two

There is no significant difference in the mean responses between registered automobile master craftsmen and officials of all the waste management regulatory agencies in Osun State as regards the disposal practices of automobile waste management in Osun State, Nigeria

Table 4: z-test analysis of significant difference in the mean responses between registered automobile master craftsmen and officials of all the waste management regulatory agencies in Osun State as regards the disposal practices of automobile waste management in Osun State

N1 = 187, N2 = 160

	Hartley Test for Equal Variance		z-test for Equality of Means						
	F	**Sig.**	**Mean Diff.**	**Std. Error Diff.**	**Z**	**Df**	**Sig. (2-tailed)**	**95% Confidence Interval for Difference**	
								Lower	**Upper**

Equal variances assumed	2.48	0.00	0.000	.046	0.000	345	1.000	-.091	.091
Equal variances not assumed			0.000	.048	0.000		1.000	-.094	.094

Table 4 shows the z-test analysis of differences in the responses of Registered Automobile Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State as regards the Collection Practices of Automobile Waste Management. The table reveals that the probability value obtained was found to be 1.000 which is greater than the probability value of 0.05 in comparison. The null hypothesis was therefore accepted. Therefore, there is no significant difference in the mean responses of Registered Automobile Master Craftsmen and Officials of all the Waste Management Regulatory Agencies in Osun State as regards the Disposal Practices of Automobile Waste Management Osun State.

Findings of the Study

The findings of the study were based on the data collected and analysed with reference to the research questions and hypotheses that guided the study.

Findings of the study are therefore as follows:

1. The finding on the collection practices of automobile waste management revealed that hazardous automobile wastes are not usually stored in closed containers neither collected by licensed agencies, waste antifreeze is not stored in separate closed container for collection, used refrigerants from vehicle are not collected in approved recovery equipment for off-site reclamation, and used tyres are not collected for landfilling.
2. Findings on the disposal practices of automobile waste management revealed that the used oils generated from mechanics workshop are disposed around their workshop to control dust and weeds; no public landfills site for disposing automobile waste; battery charger discharge used acid anywhere around their shop; vehicle air conditioning refrigerants are discharged into the air; automobile wastes such as polymer bumper, glass, dash board, seat foam and clothing are disposed with domestic waste; and discharged of used motor oil to the ground, sewers, drainage, ditches, septic tanks or streams as usual disposal practice.

Finding of the study on test of hypotheses revealed the following:

1 There is no significant difference in the mean responses between registered automobile master craftsmen and officials of all the waste management regulatory agencies in Osun State as regards the collection practices of automobile waste management in Osun State, Nigeria.

2 There is no significant difference in the mean responses between registered automobile master craftsmen and officials of all the waste management regulatory agencies in Osun State as regards the disposal practices of automobile waste management in Osun State, Nigeria

Discussion of Findings

Findings on the collection practices of automobile waste management revealed that hazardous automobile waste are not usually stored in closed containers neither collected by licensed agencies in the study area this might be as a result of lack of knowledge on their potential hazards on the part of automobile mechanics. This finding is in support of Abarca *etal*, (2013); Agarwal *etal*, (2015) who reported that the risk of exposure to automobile waste is influenced by poor management practice or neglect characterised by ineffective collection, unsafe disposal and absence of good polices. The findings of this study also shows that used waste motor oils, waste antifreeze and other material are not neither properly kept nor collected for appropriate disposal but subsequently dumped in every available space and places, especially around automobile mechanics workshops. Lack of information and public enlightenment on health implication of improperly collected and disposed automobile waste might be responsible for this. This might also be attributed to lack of regulatory framework specifically for automobile waste in the general and state environmental laws, standards and regulation. European Commission (EUC) (2010); Modak *etal*, (2012); Abarca *etal*, (2013) corroborated this finding that the waste management regulatory agencies must encourage the prevention or reduction of automobile waste and its impacts on the environment by encouraging the development of recycling and recovery technologies, improved eco-friendly products and disposal techniques in line with global practices. Abdhallahi (2015); Warlito & Charlie (2015) suggested that to avoid exposure to risk from automobile waste requires stringent management practices with adherence to safety standards in handling automobile waste particularly liquid waste.

The findings also revealed that used solvent generated in the cause repairs and maintenance work by automobile mechanics shops are properly stored and not collected by licensed agency but disposed irregularly. Solvent can cause damage to our skin, eyes, nose and throat, and respiratory system as well, which can result in chronic bronchitis and lung disease. In support of this Commonwealth of

Massachusetts (2017) explained that cleaning liquid wastes are hazardous and therefore require proper treatment and disposal. CIWMB (2003) opined that mineral spirits containing volatile organic compounds (VOC) contributed to smog formation and may be toxic when inhaled or ingested. The finding also revealed that automobile air-conditioning repair mechanics do not have recommended recovery equipment for used refrigerants let alone sending it for reclamation but usually vents it into the air. This trend is not acceptable because refrigerants vents it into the air is one of the chemical known to destroy the ozone layers, causing a rise in skin cancer and cataracts problems or permanent blindness. Also toxic fume from burned refrigerant is confirmed to be poisonous. According to Hazardous Waste Experts (2017) recycling and reclamation are the two methods usually used to manage refrigerant rather than disposing it improperly. In support of this CIWMB (2003) advocated that Freon gas is one of the chemical known to destroy the ozone layers, our planet's protection against harmful rays from the sun and thus causing a rise in skin cancer and cataracts problems and can result to frostbite or permanent blindness. It is therefore become very necessary for the automobile mechanics and others specialties in automobile maintenance sector including technical staff in automobile industries to be aware of the consequences of discharging automobile air-conditioning refrigerant into the air rather than properly contained it.

Findings on the disposal practices of automobile waste management revealed that automobile wastes such as plastics, used tyres, rags or absorbents are disposed through burning. This trend is not only unhealthy but contributed to air pollution which is a threat not only to the environment, but also residents that live in close proximity to the location of burning. The finding is in conformity with the observation of Abdhalah *etal*, (2016) which stated that the particulates matter released form uncontrolled burning of automobile waste has been proven to affect lungs especially people with asthma, heart disease, allergies and climate change. This observation is also in harmony with the opinion of Al-Delaimy *etal*, (2014) who noted that most often automobile waste generators, informal collectors (waste scavengers), those working or living near disposal sites, waste management staff be it government or private sector and those living near or working in waste treatment or recycling facilities are at high side to these risks. That is why it is important to give automobile waste proper management it deserves.

The finding also indicated that used motor oils generated from mechanics workshop are disposed around their workshop to control dust and weeds; used oils are discharged to the ground, sewers, drainage, ditches, septic tanks or streams; used oil filters are not punctured, drained and crushed for disposal. It should be noted that waste motor oil discharged into the soil has been confirmed to be the single largest source of ground water contamination which is toxic to human health. This finding is in consonant with

Jonathan and Elaine (2012) who reported that improperly managed motor oil is the major largest source of oil pollution that results in major environmental damage. For example, the benzene based aromatic component in oil can cause cancer and other health problems if the oil is inhaled or ingested. Therefore, all used oil drained, should be collected and properly managed. The finding further revealed that battery charger discharge used acid anywhere around their shop. This practice is against requirement for managing used acid from battery because it is hazardous and can pose serious environmental and health risk. This finding is in agreement with Cossu (2013); Commonwealth of Massachusetts (2017) who reported that although, automobile waste contains considerable quantities of valuable material such as metal but some are potentially hazardous if improperly disposed for instance discarded batteries, air conditioners parts when disposed in landfills produce hazardous substance like acids, mercury and chlorofluorocarbon (CFC) which leaches the soil, contaminating and polluting the ground water in the process. The result is also in conformity with submission made by Utamge *etal,* (2013) who concluded that improperly handled or discarded automobile waste can affect the PH value of water both surface and underground, pollute and reduce the quality of water; threatening terrestrial and aquatic life, cause soil acidification, and effects on human health. However the objectives of environmentally sound automobile waste disposal cannot be achievable if automobile waste is continually disposed improperly.

Conclusion

This study on the assessment of automobile waste management practices in Osun State, Nigeria, It is concluded that the automobile mechanics, and officials of all the waste management regulatory agencies are not aware of the effects of indiscriminate disposal of automobile waste. It is in this regard that the automobile mechanics and government waste regulatory agencies officials have to be enlightened on the consequences of improperly collected and disposed automobile waste especially liquid wastes. Therefore the various environmental agencies responsible for effective management of automobile waste should put appropriate monitoring and assessment system in place for the management of automobile waste in order for our environment to be secured. It is necessary that any mechanics workshop alleged for environmental pollution be sanctioned in line with environmental laws.

Recommendations

1. Automobile mechanics should be educated by environmental agencies on automobile waste best management practices, and this could be achieved through their association.

2. Hazardous automobile wastes generated by automobile mechanics shops should always be removed by licensed personnel under the supervision of environmental agencies.
3. Periodical monitoring and assessment of automobile waste management by environmental agencies should be conducted as stipulated by law, and shops alleged for environmental pollution be sanctioned.

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