CHALLENGES FOR EFFECTIVE UTILIZATION OF COMPUTERIZED DIAGNOSTICS EGUIPMENT BY MOTOR VEHICLE MECHANICS FOR TROUBLESHOOTING MODERN CARS IN FCT, ABUJA

BY

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2016/1/63733TI

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA IN PARTIAL FULLFILLMENT OF THE REQUIRMENT FOR THE AWARD OF BACHELOR OF TECHNOLOGY DEGREE(B.TECH)IN INDUSTRIAL AND TECHNOLOGY EDUCATION.

FEBRUARY, 2023

DECLARATION

I OKOLO NEWTON UCHENNA with **Matric No**: 2016/1/63733TI an undergraduate student of the Department of Industrial and Technology Education certify that the work embodied in this project is original and has not been submitted in part or full for any other diploma or degree of this or any other university

OKOLO NEWTON UCHENNA

2016/1/63733TI

Signature & Date

CERTIFICATION

This project has been read and approved as meeting the requirements for the award of B. Tech degree in Industrial and Technology Education, School of Science and Technology Education, Federal University of Technology, Minna.

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DEDICATION

This research is dedicated to Almighty God, who gave me the knowledge, understanding, strength, and courage to carry out this work to its completion. I am grateful to my wonderful parent Mr & Mrs. Titus okolo for their love, encouragement, prayers, and support.

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ABSTRACT

This study examined the challenges to the effective utilization of computerized diagnostics equipment by motor vehicle mechanic for troubleshooting modern car in Abuja metropolis. Three research questions were developed to guide the study and one null hypotheses were tested at 0.05 level of significance. The employed a survey research design. The study used a four-point scale questionnaire, which contains a total of 38-items, as instrument. The total population of the study was 80 respondents comprising 20 motor vehicle mechanic masters and 60 senior apprentice, there was no sampling because of the manageable size of the population. Mean, standard deviation was used to analyze the research questions while T-test was used to test the hypothesis. The findings of the study revealed the Lunching of x431 to read data streams, Lack of formal education and Creation of Weekend workshop training for MVM on the use of computerized diagnostics equipment. The study recommended among other things, Stakeholders who are saddled with the job of ensuring standards in automotive diagnosis, repair and maintenance in Nigeria should collaborate with leaders of roadside motor vehicle mechanics so as to develop appropriate strategies for training and retraining them on the in-depth knowledge of recent technologies needed for the manipulation of automotive digital diagnostic tools used to repair modern vehicle..

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Over the years the use of vehicles has played a vital role in the lives of humans in entirety, cutting down days and weeks of journey to hours. These days have witnessed a rapid growth of automotive industries all over the world. As the years gone by, there has been enormous technological improvement to the modern day vehicle design for it to be safer, efficient and pleasing to the customer. In the opinion of Baba, Jacob and Issifu (2018) and Motavalli, (2010) cited in Alabi, Idris, and Owodunni (2019) since modern automotive running on the roads are now being manufactured and controlled by modern technology, proper troubleshooting and maintenance of faults associated with these vehicles can only be best carried out by a skilful motor vehicle mechanics who will be competent enough to fully undertake the troubleshooting of various aspects of modern vehicles, this troubleshooting are done by computerized diagnostic equipment. One of the computerized diagonistic equipment is OBD tools.

On-board diagnostics (OBD) is an automotive term referring to a vehicle's self-diagnostic instructions programmed into the vehicle's on-board computer(s) installed in the vehicle. The on-board computer is also referred to as Engine Control Unit (ECU). The programmes are specifically designed to detect failures in the sensors, actuators, switches and wiring of the various vehicle emissions-related systems. OBD systems turns up and malfunction indication light (MIL) if the computer detects a failure in any of these components or systems (Nandhini, & Dephi, 2014). Early versions of OBD would simply illuminate a malfunction indicator light if a problem was detected but would not provide any information as to the nature of the problem. Modern OBD implementation use a standardized digital communication port to provide real-time data in addition to a standardized series of diagnostic trouble codes (DTCs), which allow one to rapidly identify and remedy malfunctions within the vehicle.

OBD systems enable owner of vehicles or automobile repair technician to gain access to the condition of the various vehicle sub-systems. The available diagnostic information through OBD has considerably been improved, as its introduction dates back to the early 1980s. The early versions of OBD simply illuminates a malfunction indicator light if there was any prevailing fault detected, but has no capability of further providing any information about the nature of the fault. The modern OBD systems have become more sophisticated and now adopt a standardized digital communications port to provide real time data in addition to a standardized series of diagnostic trouble codes, (DTCs), which allow one to quickly identify and repair malfunctions within the vehicle, as it provides almost complete control and also monitors parts of chassis, body and accessory devices as well as the diagnostic control network of the vehicle.

The OBD system is of two kinds, OBD I and OBD II. OBD I refers to the first generation systems designed to monitor manufacturer-specific systems on vehicles built from 1981 to 1995 and accessing diagnostic information typically requires getting a tool for every different vehicle make, while, OBD II is the second generation systems designed to alert the driver when emission levels are greater than 1.5 the car as it was originally certified by the EPA. Vehicles that incorporate these devices are sources of headaches to roadside motor vehicle mechanics. All vehicles (light and medium duty) built since January 1, 1996, in the United States, or in Asia and Europe designed to U.S specifications has On Board Diagnostics II (OBD) specification, although some early OBD 2 vehicles were not 100% compliant. The OBD II standard specifies the type of diagnostic connector and its pinout, the electrical signaling protocols available, and the messaging format. It also provides a candidate list of vehicle parameters to monitor along with how to encode the data for each. OBD II provides access to numerous data from the engine control unit (ECU) and offers a valuable source of information when troubleshooting problems inside a vehicle.

In Nigeria, roadside motor vehicle mechanics are very strategic when it comes to providing vehicle diagnosis, repairs and maintenance services. These services range from assisting stranded motorists along the road, by manually diagnosing and repairing vehicle faults immediately or moving the vehicle to a safe place off the road where they can systematically locate and repair possible faulty components. Roadside motor vehicle mechanics Opeyemi and Benjamin (2020) are those who possess skills set involving visual, hearing, sm

elling and feeling abilities, adopt and also apply the ‘try and error’ approach in detecting malfunctions and repairs of almost all automobiles. Reports has it that about 90 per cent of over 5,000,000 roadside motor vehicle mechanics in Nigeria use “trial and error” method to diagnose the problems of automobiles. As the technology needed by roadside motor vehicle mechanics to diagnose, repair and maintain modern vehicles advances, the problems they face has also compounded as the trial and error skill set alone are insufficient for optimal diagnosis, repair and maintenance of OBD I and II enabled vehicles. Motor vehicle mechanics in automobile workshop in Nigeria especially in Abuja encounter many challenges in the use of OBD tools. Most of the motor vehicle mechanics lack adequate skills in the use of OBD tools. Studies have shown that motor vehicle mechanics in Nigeria can avoid been thrown out of the labour market and also boost daily patronage by simply acquiring some basic computer skills relevant in the effective manipulation of digital diagnostic tools.

Basic computer skills as noted by Laura (2016), facilitate work and reduce the time required to perform tasks in work places. Some basic computer skills relevant to roadside motor vehicle mechanics include powering and shutting down a lap top computer; navigating through the computer interphases/applications; surfing the internet; sending and receiving e-mails; updating antivirus and similar software; downloading upgraded version of vehicle instruction manual from specific websites; etc.

The challenges faced by the motor vehicle mechanics in the country as touching the repair and maintenance of OBD tools enabled vehicles could be attributed to reasons such as, technophobia resulting to lack of interest in operating a lap top computer, inability to manipulate diagnostic tools, waste of time in detecting faults, damage to engines without the use of diagnostic machines in detecting faults and consequently loss of customers, poor attitudes and behaviour of today's motor vehicles mechanics among others. Another very significant challenges faced by motor vehicle mechanics is their inability to use the software, all data. Motor vehicle mechanics actually find it very difficult to attempt the use of a personal computer on which the software is installed to interpreting Diagnostic Trouble Codes (DTCs) obtained from diagnosing modern vehicle fault using scanners and comparing them with manufactures' standard. Hence, the need to challenges to the effective utilization of computerized diagnostics equipment by motor vehicle mechanic for troubleshooting modern car in FCT Abuja.

1.2 Statement of the Problem

Roadside mechanics play important role in the socio-economic development of any nation. They provide services to car owners to make their cars roadworthy. Since most vehicles are now being manufactured and controlled by modern technology, it takes a skillful auto mechanic to properly diagnose and fix problems associated with vehicles. According to Chen, Dai and Cai (2020). in the past few years, the auto industry has seen major changes in designs and special features, and keeping these cars maintained and on the road takes highly skilled technicians and mechanics to diagnose and fix problems.

Modern automobile which is an output of ICT revolves round current technological advancements in motor vehicle mechanics. It is obvious that graduates of technical colleges will perform better if they are well trained in their trade areas. Most Nigerian youths are unemployed because they lack the necessary skills. Again, some MVM technicians and teachers need skill improvement in Modern automobile Oluwatimilehin et al (2021).

Scholars such as ADAMU, (2018). argued that the technology gap should not be defined narrowly as a problem of access, hence training and content, should be included as other dimensions of the digital divide so that policy makers while making policies and programs to narrow the digital divide would not lose their focus.

Unfortunately there seems to be inadequate mechanics who are experts in carrying out the right diagnosis which can save automotive owner's time and potentially a substantial amount of money. Few studies have been carried out to assess the skills of roadside mechanics. Among the few studies that was conducted in Ghana Ziblim et al (2018). Hence, the need to identify the challenges to the effective utilization of computerized diagnostics equipment by motor vehicle mechanic for troubleshooting modern car in Abuja metropolis.

1.3 Purpose of the Study

The purpose of this study was to identify challenges to the effective utilization of computerized diagnostics equipment by motor vehicle mechanic for troubleshooting modern car in Abuja metropolis:

1. The skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis

2. The challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis
3. The strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis

1.4 Significance of the Study

The findings of this study would be of immense benefit to artisans, students MVMW graduates, Automobile Industries, Government and educational researchers.

Artisans (road side mechanics) who are products of the informal automobile sector or apprenticeship programme will benefit from the findings of this study by becoming more enlightened on the automobile emerging technologies and strive towards updating their knowledge and skills in line with the identified technology skills. This will enable them to keep pace with technological improvements for performing optimally and remain relevant in the modern automobile industry.

The automobile technology skills identified in this study when integrated into the curriculum could help the students of MVMW to acquire new set of skills required for servicing and maintenance of modern vehicles. Students will also be exposed to new body of knowledge/content on modern cars so as to enhance their understanding of their working principles and how to handle complex fault in them. The acquisition of emerging technology skills identified in this study will enable MVMW graduates to become self-reliant, self-employed and employers of labour. The findings will also enable MVMW graduates to acquire new competencies for servicing and repair of modern vehicles in order to remain relevant in the automobile industry.

Automobile servicing companies will equally find the result of this study very beneficial when incorporated into the curriculum content of MVMW in technical colleges as it will produce a pool of highly skilled automobile graduates (craftsmen) who will be versatile and adaptable to the dynamic nature of modern vehicles, thereby enhancing the performance and productivity of the automobile industry towards the sustenance of Nigeria's economic and industrial growth.

The findings of this study will sensitize the government on the performance gap between technical skills acquired by graduates of MVMW and the requirements of modern automobile industries. Hence, the government will be encouraged to organize retraining programmes and skill improvement workshops for instructors of MVMW whose responsibility it is to impart technical skills on students for gainful employment upon graduation.

1.5 Scope of the Study

The study will be carried out to determine the challenges to the effective utilization of computerized diagnostics equipment by motor vehicle mechanic for troubleshooting modern car in Abuja metropolis. The study will specifically cover challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis, the skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis, the strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

1.6 Research Questions

The following research questions will guide the study;

1. What are the skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis
2. What are the challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis
3. What are the strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis

1.7 Hypotheses

The following null hypotheses formulated will be tested to guide the study at 0.05 level of significance.

H_{01} There is no significant difference in the mean responses of motor vehicle mechanic masters and senior apprentice on the challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The review of related literature to this study is organized under the following subheadings:

2.1 Conceptual Framework

2.1.1 History of Motor Vehicles in Nigeria

2. 1.2 Electronic Engine Management System

2. 1.3 On-Board Diagnostic (OBD) Software

2. 1.4 On- Board Diagnostic Tools

2. 1.5 Diagnostic Trouble Codes and Fault Codes

2. 1.6 Skills requirements of roadside mechanics.

2.2 Related Empirical Studies

2.3 Summary of Review of Related Literature

2.1.1 History of Motor Vehicles in Nigeria

Since the dawn of time one of man's main goal is to make moving from one place to another easier and more efficient. As such, man has come up with a wide range of ideas ranging from riding horses, carts, canoe to the present-day cars, airplane, boats etc. The first internal combustion four-cycle, gasoline fueled engine was manufactured in 1876 in Germany, Carl Benz commenced the first commercial production of vehicles with combustion engine. Vehicles reached modern stage of development by the 1890s. The models in the 1980s were so successful which has led to no significant transformation in the principles of the automobile engine used then (Melosi, n.d.). Cars today are used throughout the world as the most popular mode of transportation, making it highly important to people. Although the car was to have its greatest impact to man, making journey easy, like any other mode of transportation it has its flaws, the constant need for maintenance and the non-ending need for repairs. Though there are many types, model, brand, make of cars, they all require these services.

The history of Automobile in Nigeria can be traced back prior to 1960 when Nigeria had her independence (Chamberlain and Ede, 2013). The use of vehicles was introduced to Nigeria when oil was flourishing in the 70's by the western world. The Nigerian government in partnership with some advanced economies like Germany, Britain, America, and France, issued license of operation and control policy, built six Vehicle assembly plants in various states of the country, Peugeot Automobile Nigeria limited (PAN) established in the year 1975 in kaduna, Volkswagen of Nigeria Limited (VWON) Lagos 1978, Anambra Motor Manufacturing Limited (ANAMMCO) Emene – Enugu (1980); Steyr Nigeria Limited Bauchi in Bauchi, National Truck manufacturers (NTM) Kano Fiat Production in Kano, LeyLand Nigeria Limited (LNL) Ibadan, between 1970 and 1980 (Akaigwe, 2010).

The launch of the six-vehicle plant in Nigeria served as an economical boost to the country (Aganga, 2013). Former minister of trade and investment (Aganga, 2013) said that "automobile industry is an engine of growth and stimulus to other economic activities like creating of employment opportunities growth of other satellite industries, enhancement of technology transfer of skill acquisition" since the establishment of the vehicle assembly plants in Nigeria, the country's economy has recognized an enormous improvement as a result of the ease in transporting finished products of crude oil from the factories to fuel filling stations. Farm produce are transported with ease between the six geopolitical zones.

Humans were able to move from one point to another with ease. Compared to when man was using other means of transportation such as horses, camels, etc. Over the years there has been a sharply decline of vehicle manufacture in the country, some of the assembly plants manufactured in the 70s and 80s are not operational, due two challenges that has befall them (Okuhit, 2015). Majority of automobile companies in Nigeria in present times deal only on car sales, about 80% of vehicle on the roads today are fairly used vehicles popularly known as Tokumbo, as a result of the decline in vehicles manufactured in Nigeria (Chamberlain, 2013). According to (Izogo & Ogba, 2016), the need for vehicle repair services have been on the rise due to the change from manual to automatic transmissions having more complex systems due to technological variations.

2. 1.2 Electronic Engine Management System

Most of today's vehicles are controlled by electronics, with more devices being developed and fitted to vehicles each year. The most important one to be built into vehicles has to be the Engine Management System**.** It is the brain of the car that controls the fuel supply and the ignition by combining the two separate functions into one main system. The Engine Management System controls the whole of the combustion process, making the engine more efficient and less polluting than ever before (Harrow, 2015). The automotive industry has become more inclined towards using advanced technologies to reduce emissions and increase fuel economy of vehicles, thereby controlling NOx and CO pollution levels. Engine management system makes sure that the right amount of fuel is combusted with the right amount of air-based on the signals received by the engine control unit (ECU) from various sensors fitted in the vehicle. Hence, engine management systems play an important role in both emissions reduction and improvement in fuel-efficiency of vehicles (Carley, 2016). The modern engine management system has a self-test capability that regularly examines the signals from engine sensors and in some instances the actuators. In the event of a fault being present the ECU internally logs a code. This code can be extracted from an output terminal, known as a diagnostic plug or socket or serial port, by a suitable fault code reader (Randall, 2006).

During the operating time of the vehicle, the ECUs constantly check the sensors they are connected to. The ECUs are then able to determine whether a sensor has a short circuit to ground or battery voltage, or if a cable to the sensor is open circuit. By comparing the measured values and the stored data, an ECU is able to determine whether the measured values exceed or are still within the tolerance required. Combining information provided by other sensors allows the ECU to monitor for plausibility of the sensor signals. When a defective sensor is detected, the measured values are replaced by a nominal value, or an alternative value is calculated using the information from other sensors to provide a limp home function. With the help of an appropriate code reader or scanner, a technician can communicate with the ECUs, read the fault memory and the measured values, and send signals to the actuators (Denton, 2006).

2.1.2.1 Electronic Control Systems in a Motor Vehicle

Duffy, (1995) indicates that in control system applications, sensors and actuators are in many cases the critical component for determining system performance. This is especially true for automotive control system applications. The availability of appropriate sensors and actuators dictates the design of the control system and the type of function it can perform

According to Hillier, Coombes & Rogers, (2006) modern motor vehicles are fitted with a wide range of electronic and computer controlled systems. There are many reasons for the increased use of electronic systems. Although vehicle systems differ considerably, they rely on the same fundamental electrical and electronic principles that must be fully understood before a vehicle technician can work competently on a modern motor vehicle. Electronics and electronic control or computer control have become increasingly necessary in motor vehicles and without electronic control of vehicle systems primarily the engine management and emission control systems, emission from the engines could not have been reduced by so much. Legislation has imposed tighter control on emissions; a balance has been struck between what is wanted and what can be achieved. The legislators seek continued reductions in emissions and the vehicle manufacturers have been able to achieve tremendous results, but without electronics it would not have been possible to reduce emissions to anywhere close to the current low levels.

Safety is another area where electronics have enabled improvements. The design of a motor vehicle is very dependent on computers that can analyse data and then help to incorporate improved safety into the basic vehicle structure safety systems such as anti-lock brakes and airbag systems could not function anywhere like as efficiently or reliably without the use of electronics. (Hillier et al, 2006).

2.1.2.2 Electronic Control Units (ECU)

An electronic control unit (ECU) receives information from sensors, makes calculations and decisions, and then operates an actuator or provides signals for electronic components such as digital display. An ECU cannot achieve its main objectives which are to operate an actuator or electronic component, unless the appropriate signals are received. This is true of all ECU controlled vehicle systems, and almost all other computers. Some form of input signal is required before a calculation and control can take place (Hillier et al, 2006).

2.1.3 On-Board Diagnostic (OBD) Software

Modern engines are controlled electronically using real time software in a device known as the Engine Control Unit (Donal, Undated). Many scan tools offer software for vehicle systems other than Engine and Powertrain such as Antilock Brake, Transmission, Chassis and Body (Mitcham, 2000).The ‘smart card’ is the equivalent of computer software and it enables the tester to use the ECM processor power to interrogate circuits. The test instrument is thus able to test all circuits that are served by the ECM. The test connection plug is also known as the serial port because test information is fed out serially (one bit after the other, e.g. 10110011). A considerable advantage of the serial port is that it permits testing without the need to disconnect wiring. According to William (2011), OBD test consists of a scan tool that plugs directly into the vehicle’s computer, giving an instant reading on the status of the emission systems. The test consists of a plug that connects to the vehicle's computer and downloads emission system information. The test does not change, alter or otherwise affect the computer. It only reads emission system information. Furthermore, William (2011) stated that three pieces of information can be downloaded from a vehicle's software (OBD II) system with a scan tool':

- Whether the emissions Malfunction Indicator Light (MIL) commanded 'on' or 'off';
- Which, if any, manufacturer fault codes or Diagnostic Trouble Codes (DTCs) are stored (i.e. have been activated)
- The status of the Readiness Monitors.

2.1.3.1 Malfunction Indicator Light (MIL)

While engine check lights have been installed on vehicles for a long time, the OBD II system Malfunction Indicator Light (MIL) has a new standard application and importance. One of the prime objectives of OBD II is to alert the driver and/or the repair technician that there is a problem with one or more of vehicle's systems. The first level of alert is achieved via the Malfunction Indicator Light (MIL). While the most common designation is MIL, this indicator has also been referred to as the Check Engine Light and the Service Engine Light. When the OBD computer detects a problem it may illuminate the MIL on the vehicle's dashboard. This light cannot be turned off until the necessary repairs are completed or the condition no longer exists. If the MIL illuminates with a steady light, the vehicle operator should contact a repair technician and schedule a service visit to determine what is wrong. Sometimes the indicator light goes out after being illuminated for a short time. This could happen if, for example, the gas cap was not on tight, but was then tightened. Under certain conditions, the dashboard light will blink or flash. This indicates a severe problem. If this occurs, the vehicle operator should stop the car immediately and refer to the owner's manual to determine if the car can be driven or should be towed to a service station. Continued operation of the vehicle could result in damage to emission control components, specifically the catalytic converter (Nevada 2003, New Hampshire 2003).

Although some vehicle on-board computers may monitor non-emission-related components and systems at the manufacturer's discretion, in the USA federal regulations require that the MIL only be illuminated for emission-related malfunctions (Sosnowski 2001).

2. 1.4 On- Board Diagnostic Tools

On-Board Diagnostic tools are computer based read-out equipment that is designed to interface with a vehicle's on-board computer for the purpose of reading diagnostic trouble codes (DTC's) and readiness monitor status and to display those codes and parameters (Burelle, 2004). The scan tool communicates directly with the vehicle data stream. One of the biggest advances that OBD 11 has brought to vehicle repair was the ability of a scan tool to communicate with any OBD 11 compliant vehicle. OBD-11 regulations spell out a specific way that all vehicles must communicate with these generic scan tools. According to Nice (2001), the functions of generic scan tools include:

- Automatic determination of the communications protocol.
- Display of the Readiness Test Status.
- Display of the vehicle's Current Data Parameters.
- Display of Freeze Frame Data saved by the control unit.
- Display of Diagnostic Trouble Codes (DTC's) saved by the control unit.
- Clearing Emission Related Diagnostic Information (DTC's and diagnostic parameters).

- Display of O2 Sensor Test Results
- Display of the On-Board Monitoring Test Results for Non-Continuously Monitored Systems.
- Display of the On-Board Monitoring Test Results for Continuously Monitored Systems (Nice, 2001).

The monitor asks you a series of qualifying questions to identify the vehicle. These questions are necessary because the data cartridge contains information on both OBD-1 and OBD-11 vehicles. An OBD-11 only cartridge would not need to know what type of vehicle you were working on because the data exchange protocols are standardized and the diagnostic link connector (DLC) is always the same. You can interface this system to your personal computer (PC) and use Windmill computer software to automatically collect the data at regular intervals. There are interfaces that connect to other PC ports- for example, the USB port. The software is used to request data from the OBD System, read the response and log and display the data. If you wish to perform real-time calculations on the data, for example to see current fuel consumption, the software needs to be able to channel the data to a spreadsheet or similar program. Windmill software can do all these things. With Windmill, you can interface several different devices, so you could add a GPS receiver to record location alongside your fuel consumption and emission data sensor readings can be used for many applications. There may be as many as 300 readings available from your vehicle: including engine rpm, vehicle speed, emitted oxygen, intake air temperature and ignition timing. Add a Global Positioning System (GPS) receiver and you could log the location of each reading Smith (2006) gave some tips on how to get the OBD data into a laptop. They include:

- You need an interface to connect the vehicles on board computer to your laptop. An interface is a cable that connects two different gadgets. Although the on board diagnostics are standard across cars, the interface is not. You need to buy one that matches your vehicle. Connect the interface between the vehicles 16-pin diagnostic port and one of the laptops ports.

- You need some software (Windmill) to request data from the OBD, read the response and log, display and distribute the data. The free Windmill 4.3 software ASC11 data from the PCs COM Port. So if you plan to use Windmill, make sure that your interface can be plugged into the COM (RS232) port and transmit ASC11 data. With Windmill, you can read any of the OBD information: the standard stuff and any extras provided by your vehicles manufacturer.

- You will need to perform some calculations on the data so a spreadsheet like Excel would be useful.

- To obtain data, send a request then wait for a response. A command to request data is usually two or three bytes long, but the OBD standard allows for up to seven. The requests are sent in hexadecimal. The first byte sent is the Mode byte. There are nine modes of operation in the OBD standard. For regularly logging data, you will generally use Mode 1: Show Current Data. So start all your requests for data with "01". The next byte describes the information wanted. You specify this with a Parameter Identification (PID) code or number which is a hexadecimal number. Here are some of the PIDs you might use:

PID Description (Number of bytes returned)

05 Engine Coolant Temperature (1 byte)

0A Fuel Pressure (1 byte)

0B Intake Manifold Pressure (1 byte)

0C Engine Revolution Per Minute (2 byte)

0D Vehicle Speed (1 byte)

0F Intake Air Temperature (1 byte)

10 MAF Air Flow Rate (2 byte)

IF Run time since engine start (2 bytes)

2F Fuel Level Input (1 byte)

31 Distance travelled since codes cleared (2 bytes)

33 Barometric Pressure (1 byte)

46 Ambient Air Temperature (1 byte)

To request a vehicle speed reading, therefore, you would send 010D.

41 0D 37 would be:

41 – Shows a response (4) from a Mode 1 request.

0D- The PID of the measurement, speed in our case.

37 – The data value in hexadecimal (Smith, 2006).

With Windmill, we would extract the data value from the rest of the message. So we might tell it to ignore six characters then extract two. For speed just one hexadecimal number is returned. Other types of data may return 2 or 3 hexadecimal numbers (bytes). We now need to convert the hexadecimal value to decimal. If using Windmill, we could send the data to Excel (or another analysis program) and perform the conversion using the HEX2DEC command. You may need to apply a scale and an offer to the results, or you could do so after data collection in Excel.

Finally, you may need to tell your interface that you have finished the request message. The character to do this depends on your interface; in ELM interface, it is a carriage return. Some interfaces require you to send a fixed number of bytes so no ending character is required. Once configured, Windmill Software regularly sends this command to the OBD interface and stores the reading received. Bell (2005) commenting on the use of diagnostic tools, gave these instructions:

- Turn the Ignition off.
- Connect the OBD scanners cable and the vehicles 16-pin Data Link Connector (DLC).
- Turn the ignition on. But do not start the engine.
- Turn the OBD scanner's power on.
- Press the Y button. A sequence of messages showing the OBD procotols will be observed on the display until the vehicle protocol is detected.

In addition, Bonnick (2001) stated that skills required by vehicle technicians, for effective diagnostic work on vehicle electronic systems, consist of many elements. The most important of these may be classed as 'key skills'. These key skills may be summarized as follows:

- Use appropriate 'dedicated' test equipment effectively.

- Make suitable visual inspection (assessment) of the system under investigation.
- Make effective use of wiring diagrams.
- Use instruction manuals effectively.
- Use multimeters and other (non-dedicated) equipment effectively.
- Interpret symptoms of defective operation of a system and, by suitable processes, trace the fault and its cause.
- Work in a safe manner and avoid damage to sensitive electronic components.
- Fit new units and make correct adjustments and calibrations.
- Test the system, and the vehicle for correctness of performance (Bonnick, 2001

2.1.5 Diagnostic Trouble Codes and Fault Codes

OBD Diagnostic Trouble Codes (DTC's) are those codes common to all OBD compliant vehicles, regardless of make or model of cars. A common set of generic DTC'S is what allows a code scanner to work on so many different vehicles. According to Burelle (2004), Diagnostic Trouble Codes is an alphanumeric code that is set in a vehicle's on-board computer when a monitor detects a condition likely to lead to (or has already produced) a component or system failure, or otherwise contribute to emissions exceeding standards by 1.5 times the certification standard. A trouble code is a number or letter/number combination that refers to a specific problem or fault in a vehicle system. When the OBD II computer detects a problem, it sets and stores a Diagnostic Trouble Code (DTC) or Fault Code. These codes are intended to help the technician determine the root cause of a problem. When a car is taken in for diagnosis or for an annual emissions inspection, the repair technician retrieves any set Diagnostic Trouble Codes or fault codes from a vehicle's computer using the 'scan tool'.

The DTC is a five-character code with both letters and numbers called the alphanumeric system. The first character of the code is a letter. This defines the system in which the code was set. Currently, there are four possible first character codes:

- "B" for Body
- "C" for Chassis
- "P" for Powertrain
- "U" for Undefined (designated for future use)

The second character is a number. There are four possible second character codes:

- "0" – The fault is defined or mandated by OBD II.
- "1" – The code is manufacturer specific.
- "2" – Designated for future use.
- "3" – Designated for future use (Bosch, 2013).

Interpreting Diagnostic Trouble Codes (DTCs)

There are four main types of DTC codes defined by the SAE standards. These are the following:

First digit will be:

- Powertrain Codes (P codes) 0 - 3
- Chassis Codes (C codes) 4 - 7
- Body Codes (B codes) 8 - B
- Network Codes (U codes) C – F (Bosch, 2013).

These codes identify where or what system the fault occurred. The powertrain codes are the most common and represent codes that occur in the engine management system. In addition, there are now over 400 possible trouble codes that can be stored in the OBD II system (Bordoff 2003). According to Carley (2003), the OBD II system can set emission related Diagnostic Trouble Codes (DTCs) and service codes that are not emission related. These codes are of the following types:

Type A - Diagnostic Trouble Codes are the most serious and will trigger the MIL lamp with only one occurrence. When a Type A code is set, the OBDII system also stores a history code, failure record and freeze frame data to help you diagnose the problem.

Type B - Diagnostic Trouble Codes are less serious emission problems and must occur at least once on two consecutive trips before the MIL lamp will come on. If a fault occurs on one trip but doesn't happen again on the next trip, the code won't 'mature' and the light will remain 'off'. When the conditions are met to turn 'on' the MIL lamp, a history code, failure record and freeze frame data are stored the same as with Type A codes.

Type C and D codes are non-emissions related. Type C codes can cause the MIL lamp to come on (or illuminate another warning lamp), but Type D codes do not cause the MIL lamp to come on.

2. 1.6 Skills requirements of roadside mechanics.

Motor vehicles which were manually operated some centuries back are now electro-mechanically operated. Computers are common place in modern day automotive design; braking, steering, starting and suspensions system are few examples of items now technologically operated. Automotive technology has been evolving since the turn of the century. Santini, (2004) stated that during the period from 1930 to 1970, the main body of automotive technology was mechanical they were relatively simple for any roadside mechanic to repair. By the early 1980's the introduction of information technology in automotive has triggered the most rapid technological advancement in the automotive industry. With the computers available, automotive designers have developed numerous sensors and controls. Now computers have even been used as components parts for brakes, steering, chassis systems and other parts of automobile. Technologies have recently been incorporated in all new automotive subsystems and have become standard implementation on many others. Such features as antilock braking system and airbag could only be achieved practically through the use of technology. These features are rapidly becoming standard features in all new automotive owing to change in customer's taste for automotive and status symbols attached to car ownership. All these systems require maintenance and repairs. The competencies required to maintain automotive of the 1900,s show little similarity with the competency required of the1970s. Around 1970,s and 1980,s roadside mechanics used what is termed the 'try and error' to repair almost all automotive vehicles Lindsay, (2013). Rapid development of automotive technology has presented some challenging problems for roadside mechanics in the country. Ribbens, (2003) noted that the use of scan tools like On-Board Diagnostic, One, Two and Three (OBDI, OBDII, and OBDIII) are common place in the repair of automotive in the manufacturer's approved service centers today. The on-board diagnostic (OBD) is an automotive term referring to a vehicle's self-diagnostic and reporting capability.OBD systems give the vehicle repairer access to the status of the various vehicle sub-systems and give the mechanic a clue as to where to look at when a problem occurs on the vehicle. But for one to be able to use this tool the mechanic must be able to understand the principles behind its usage Edunyah, (2015).

The US Department of Labor Statistics estimated that due to the increasing average lifespan of cars and growth in the number of cars being driven, the department projected the demand for automotive mechanics to increase 9% between 2012 and 2022. Those with specialized knowledge or training will have the best opportunities. The rate of change in technology is exponentially increasing. Nations, industries, and individuals must develop their capabilities to keep abreast of technological changes and to harness technology. Automotive workshops are category of small industry that contributes to the maintenance of vehicles. The repairing workshop plays an important role in the economy of every nation through maintaining motor vehicles in an efficient manner which helps in making transport services more efficient. Automotive workshops and repair shops can be divided into several categories. A majority of automobile repair workshops are independently owned and operated businesses Kayemuddin and Kayum (2013).

In Ghana, most of the vehicle maintenance and repair jobs are performed by roadside mechanics, this research seeks to assess the skills of the mechanics in the advent of automotive technology advancement and the opportunities available to these roadside mechanics so as to prevent them from becoming career disabled due to increase in vehicle technology. The Motor Vehicle Repair and Service Industry (MVRSI) is a thriving industry, with several small open-air garages in towns across Kenya Kinyanjui, (2000). With increasing technical sophistication, the human resource in the MVRSI requires continuous development of technical and interpersonal skills necessary for them to remain relevant in their practice. Barber, (2003) advanced three reasons for the importance of technical training: changes in administrative structures, technological advancement and tougher occupational health and safety laws. He provides an example of a vehicle repair mechanic who has to undertake extensive ongoing training to maintain and fix the latest models of cars with computer-operated parts, keyless entry, global positioning systems, automated stabilizing systems, and other related inventions. In Kenya, United Nations Development Programme (UNDP), (2010) observed that most Vocational Education and Training (VET) institutions used very old models of vehicle engines for their automotive practical training. Thus, the graduates are confronted with challenges at the workplace because their training is not aligned to the technological know-how required for the industry.

Today, non-formal apprenticeship programs are provided in many areas such as tailoring, hair weaving and iron bending, carpentry, brick laying, auto-mechanics, auto-body repairing, air conditioner maintenance, tire vulcanizing, electrical installing, furniture making, welding/ fabrication, sheet metal work, machining (turning), fitting and foundry work and so on. An important component of the non-formal apprenticeship programs in Nigeria is that a contract agreement is entered into between the master craftsman and the apprentice. Such contractual agreement incorporates the fee payable by the apprentice and the period of training. Also spelt out is the penalty when either party breaks the contract. Uwameiye and Omofonmwan (2014) stated that the set-up for the training workshop involves the master craftsman (trainer), and the apprentice (trainee). The master craftsman has full control of the workshop. The roadside workshops are organized along the line of the master/apprentice situation, where the master craftsman owns all the tools, workshops and skills from which the apprentices benefit. According to Okogba, (1991) they often illiterate or semi-illiterate master models develop training programs lacking basic theoretical concepts. Although local tradesmen may function successfully in the labor market, they remain in the final analysis in the lower cadre of manpower personnel and their practical expertise degenerates into mechanical manipulation.

The roadside apprentice program has contributed immensely to the Nigerian economy. It has provided training opportunities to many Nigerians who would have become social nuisances to the public. It has become an indispensable complement to formal education. However, the contribution the roadside apprenticeship is making to the national economy is high; leaving the master craftsman to control the training situation of the apprentice seems to place too much responsibility on that person. The Federal Republic of Nigeria's realization of the importance of the roadside apprenticeship can be seen in its policy which states that "the question of accreditation for roadside mechanics and others who complete training programs through non-formal education will be undertaken by the National Board for Technical Education (NBTE)". It is more than three decades since this policy was promulgated, but no roadside mechanic has been accredited, and there is no plan for implementing the policy. Also, there have not been any objective statements written for these apprentice programs Uwameiye and Omofonmwan (2014).

Apprenticeship training leads to the acquisition of skills as well as basic scientific knowledge. It is a planned program and learning experiences that begins with exploration of career options, supports basic life skills, and enables achievement of high preparation for industry-defined work, and advanced and continuing education McLeod, (2014). Vocational education is a practical instruction that gives learners specific occupational skills. Thus vocational education and training prepares learners for careers that are based in manual activities and traditionally non-academic that relate to a trade, occupation or vocation. Specifically, vocational and technical education gives individuals the skills to learn and become productive citizens and for advancement in the workplace Oni, (2006). Some scholars perceive technical and vocational education as one of the "bulwarks of social efficiency" as the preparation of a well-trained workforce Camp, (1983). And because of the unrelenting changes in the new global economy one may not be relevant in the labor market in future without a certain level of technical skills. The neglect of vocational and technical education in Nigeria leads to the dearth of skilled technical manpower to maintain the nation's critical infrastructure and to tackle its developmental challenges Dike, (2009).

Automotive service technicians and mechanics could use high-tech skills to inspect, maintain, and repair heavy duty automotive and light trucks with gasoline engines. The increasing sophistication of automotive technology now relies on workers who can use computerized shop equipment and work with electronic components, while maintaining their skills with traditional hand tools. Because of these changes in the occupation, workers are increasingly called "automotive service technicians," and the title "mechanic" is being used less and less frequently.

According to Uwameiye and Omofonmwan (2014), roadside mechanics acquire skills. These practical skills only involved assembling of parts. These practical skills are mostly devoid of diagnostic skills and knowledge information. Because of this deficiency, apprentices were hardly able to perform any operations that are new to them, except those they have seen their master carry out. In the practice of skills, the recipients observe the master trainer perform the operations, and through imitation, the apprentices then practice the skills until they become proficient in them. Productivity was low in automotive workshops in Bangladesh as the service was rendered by hands and use tools and equipment which were mostly outdated and these old tools affected their ability to work on complex systems especially electronic and automatic transmission systems Kayemuddin and Kayum (2013). The study further revealed that abundant labor is available in Bangladesh and as such all of these workshops used labor intensive technology.

The study conducted by Sambo, Idris and Shamang (2012) showed that working experience or number of years spent with master craftsman affects the skills acquired by apprentice. To become a master craftsman, you need to have strong practical skills. You need to be good at problem-solving and faults detection. You also need to have good human relations and great customer service skills. The Internet is even spreading to mechanics, with certified mechanics providing advice online. Mechanics themselves now regularly use the Internet for information to help them in diagnosing and/or repairing vehicles. Service manuals for vehicles have become significantly less prevalent with computers that are connected to the Internet taking their position Jeffrey, (2015).In repairing cars, the main role of the mechanic is to diagnose the problem accurately and quickly. They often have difficulty in diagnosing electronic faults. Study shows that their job may involve the repair of a specific part or the replacement of one or more parts as assemblies Funkhouser, (2013). Roadside mechanics have to compete with large companies which use expensive diagnostic equipment and have advantages in purchasing, distribution and marketing. Small companies can compete effectively by providing superior customer service or offering specialized services Auto repair Business and Trends, (2012). From Jalal, (2013), a skill gap analysis that majority of the mechanics in Nigeria lack the relevant knowledge about vehicle electrical and electronic components repair. Technology in the auto sector advances continually at a very fast pace. Most cars on our roads today are built with a lot of electronically controlled systems. The only way to catch up with this advancement is training and re-training. According to Kayemuddin and Kayum (2013) in the past few years, the auto industry has seen major changes in designs and special features, and keeping these cars maintained and on the road takes highly skilled technicians and mechanics to diagnose and fix problems. Mechanics are responsible for inspecting, repairing and maintaining cars, buses, trucks, motorcycles and other vehicles. In recent years, the systems and components of these vehicles have become more complex. However, mechanics lack the skills to work not only with special tools and diagnostic equipment, but also with sophisticated electronics and computer systems Funkhouser, (2013).

Innovations in the automotive industry have gradually transformed what it means to be an auto repair worker. As the cars on our streets have become more computerized, so, too, has the job of maintaining and fixing these vehicles. And so a trade that was once largely mechanical is today primarily technical, and therefore requires workers to be skilled computer users, strong readers and able mathematicians. According to Otis , (2007) the skills of an auto mechanic will vary greatly. Some mechanics develop the skills to work on all parts of a vehicle, while others choose to specialize in a particular field. He father said that a competent car mechanic should also have mastery over a wide variety of integrated skills, such as the electrical system, fuel system, and the air conditioning system. Computer skills are also needed in the day-to-day operations, and are as much a part of the tool box as wrenches. As knowledge is gained, it becomes easier to move into higher paying positions.

As time goes on, many older master craft men may be out of business because they don't possess the computer skills necessary to work on modern cars and also impact knowledge on the aspiring auto mechanics of today. With additional skills, it's easy to gain employment.

2.2 Related Empirical Studies

Ugodo (2015) carried out a study on emerging technology skills required by technical college graduates of Motor Vehicle Mechanic's Work (MVMW) for establishing automobile enterprises in Anambra and Enugu States of Nigeria. The study sought to answer six research questions. Six null hypotheses were also tested at 0.05 level of significance. A descriptive survey research design was adopted for the study. The population for the study was made up of 120 automobile industry workers and 9 instructors of Motor Vehicle Mechanic's Work (MVMW) totaling 129 respondents from notable automobile manufacturing and maintenance workshops and NBTE accredited technical colleges in Anambra and Enugu States. There was no sampling for the study since the entire population was used. One hundred and twenty-nine emerging skills item questionnaire structured on a four point rating scale was the instrument used for data collection. The face validation of the instrument was carried out by five experts from notable automobile manufacturing and servicing companies and institutions in Enugu State. A reliability test of the instrument was also conducted and analysed using Cronbach Alpha coefficient method and yielded an overall reliability coefficient of 0.92. Data generated from the use of the questionnaire was analyzed with Statistical Package for Social Sciences (SPSS) using mean and t-test statistics to answer the research questions and hypotheses respectively at 0.05 level of significance. Findings revealed that emerging technologies in modern automobile systems require the skills of technical college graduates of MVMW programme in the maintenance of engine, ignition, fuel, transmission, brake and on-board diagnostic (OBD) systems for establishing automobile enterprises in Anambra and Enugu State of Nigeria. The findings identified the implications of the study with respect to National Board for Technical Education (NBTE), technical college administrators, technical instructors, MVMW graduates, students and artisans. Based on the findings of the study, appropriate recommendations were made, among which is that the identified emerging technology skills should be integrated into the national curriculum of MVMW programme in technical colleges; curriculum for training auto-mechanic instructors should also be reviewed to include modern automobile technologies; graduates of MVMW are to be trained on modern automobile technologies in automobile manufacturing and servicing industries for a minimum of six months after their formal educational programme in technical colleges before certification. The difference between the study and current study is that the current study is carried out in Anambra state while the study is carried out in Abuja

Raymon (2016) conducted a study on assessment of the knowledge of local auto mechanics on electronic engine management system and on-board diagnostic (OBD) scan tools. Study area: ho municipality. On-board diagnostics (OBD) for vehicle engines has become increasingly important because of environmental legislative regulations such as OBD II to detect faults in an engine by monitoring various sensors and utilizing fault detection algorithms. In order to carry out repair work on modern vehicles effectively and efficiently, OBD scan tool, deeper knowledge on on-board diagnostic and electronic engine management system is required. This research assessed the knowledge of local auto mechanics on electronic engine management system and on-board diagnostic (OBD) scan tools. A non-random, quota sampling design technique was used in selecting sixty five (65) local auto mechanics in local repair garages in Ho municipality. Structured self-administered questionnaires were given to the auto mechanics to fill. It has been found out that, over 65% of mechanics in the municipality do not have knowledge on electronic engine management system. 85% of local auto mechanics do not have any type of On-board Diagnostic (OBD) scan tool at their repair garages. The findings also revealed that, 86.2% of local auto mechanics in the municipality do not know how to use any On-board Diagnostic (OBD) scan tools to retrieve trouble codes on modern vehicles if the vehicles should develop fault. Finally, it has been found that, over 60% of local auto mechanics do not have knowledge on diagnostic trouble codes (DTC). Among the recommendations made to address the situations is the urgent need to organize refresher courses for local auto mechanics to keep them abreast with modern vehicle diagnostic techniques. This could be done through the Skills Development Fund (SDF) administered by council for technical vocational education and training (COTVET). The similarity between the study and the current study is that they both based on OBD Tools.

Medashe (2020) carried out a research on Specifications and Analysis of Digitized Diagnostics of Automobiles: A Case Study of on Board Diagnostic (OBD II) On-board diagnostics, (OBD) is an automotive term that refers to a vehicle’s self-diagnostic and reporting ability. OBD systems enable owner of vehicles or automobile repair technician to gain access to the condition of the various vehicle sub-systems. Modern motor vehicles are highly sophisticated machines that incorporate development in electrical, electronics and mechanical engineering. The traditional “trial-and-error” mode of diagnosis could no longer be efficient to meet up with the need for maintenance and repairs on such vehicles. Therefore, this probes a challenge to meet up with the technological trend, and hence it becomes imperative to adopt new mode of diagnosis with high efficiency on the new generation motor vehicles. To facilitate and enhance the early detection of faults and malfunctions related to emissions control components, different diagnostic tools like Launch X-431 and Autel Maxidiag (Elite Series) were used and from the research carried out and the various results obtained from the various diagnostics of some selected automobiles from German Make, American Make, and Japanese Make vehicles, the diagnostics results provided an appreciated feedback through the triggering of Malfunction Indicator Light (MIL) and thereby with the use of diagnostic scan tools, the failures and faults within the engine compartment were detected. It was evident that On Board Diagnostic has the capacity to facilitate and enhance the early detection of vehicle malfunction and faults related to emissions control components and as a result reducing high emissions caused by emission related malfunctions.

2.3 Summary of Review of Related Literature

The conceptual framework of the study covered the following sub-headings: History of Motor Vehicles in Nigeria, On-Board Diagnostic (OBD) Software, Diagnostic Trouble Codes and Fault Codes, On- Board Diagnostic Tools, Electronic Engine Management System, Skills requirements of roadside mechanics. Adequate and relevant related empirical studies were also reviewed in order to guide the researcher in selecting appropriate methodology for this study. Many of the empirical studies which were found relevant, presented some empirical works on competency improvement skills of Mechanics in other parts of Nigeria.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Design of the Study

The study adopted a the descriptive survey research design used identify challenges to the effective utilization of computerized diagnostics equipment by motor vehicle mechanic for troubleshooting modern car in Abuja metropolis. Survey design according Nworgu (1991) is aimed at collecting data on and describing in a systematic manner, the characteristics features or facts about a given population. Osuala (2005) said that it is a design which studies the characteristics of people, the vital facts about people and their beliefs, opinions, attitude, motivation and behavior. The design is suitable for the study because it solicit information from motor vehicle mechanic and senior apprentice.

3.2 Area of the study

The study was carried in out in Abuja.

3.3 Population for the Study

The population for the study consists of 80 respondents comprising 20 motor vehicle mechanic masters and 60 senior apprentice.

3.4 Sample and Sampling Technique

There was no sampling since the population is of manageable size.

3.5 Instrument for Data Collection

A structured questionnaire as an instrument that was used for data collection for the study. The questionnaire was made up of four sections (A, B, C, and D). Section ‘A’ contains items on personal information of the respondents. Section ‘B’ seeks challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in

Abuja metropolis. Section 'C' find out skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis. While Section 'D' find out strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis. The questionnaire items were based on four points scale types. Items for section 'B', 'C' and 'D' contain four responses category each. The response categories for section 'B', 'C' and 'D' are strongly Agree (SA), Agree (A), and Disagree (D) and strongly disagree (SD). These response categories will be assign numerical values of 4, 3, 2 and 1 respectively. Respondents were require checking (√) against the response category that best satisfies their opinion.

3.6 Validation of instrument

The instrument was validated by three lecturers in the department of Industrial and Technology Education, Federal University of Technology, Minna and contributions on the appropriateness of the instrument will be considered in the production of the final copy of the research instrument.

3.7 Reliability of instrument

In order to determine the reliability of the research instrument, a pilot test will be conducted using fifteen in other locations. During the test, the questionnaires were distributed by the researcher. The questionnaire was filled by the respondents and then returned to the researcher. The data collected was analyzed using Crombach Alpha.

3.8 Administration of instrument

The instrument that was administered to the respondents by the researcher and three research assistant in the study area.

3.9 Method of data analysis

Data collected was analyzed using mean and standard deviation for the research questions while t-test was used to test the hypothesis at the 0.05 level of significant. A four (4) point rating scale will be to analyze the data as shown below.

Strongly Agree	(SA)	=	4points (3.5 – 4.0)
Agree	(A)	=	3points (2.5 - 3.49)
Disagree	(D)	=	2points (1.5 – 2.49)
Strongly Disagree	(SD)	=	1point (1.0 – 1.49)

Therefore, the mean value of the 4 point scale is:

$$\bar{X} = \frac{4+3+2+1}{4} = \frac{10}{4} = 2.5$$

3.10 Decision Rule

The cutoff point of the mean score of 2.50 was chosen as the agreed or disagreed point. This was interpreted relatively according to the rating point scale adopt for this study. Therefore, an item with response below 2.49 and below was regard or consider as disagreed while an item with response at 2.5 and above was regard or considered as agreed.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

4.1 Research Question 1

What are the skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis?

Table 4.1: Mean responses of motor vehicle mechanic masters and senior apprentice on the challenges faced by women in carrying out the building construction skills in building industries.

		N_1= 20		N_2=60
S/N	ITEMS	$\bar{X}$	**SD**	Remark
1	Ability to identify Lunch x431	3.71	.508	Agreed
2	Ability to identify Autobus V30	3.79	.567	Agreed
3	Identifying of necessary cables and adapters for both Lunch x431 and Autobus V30	3.79	.544	Agreed
4	Ability to differentiate Lunch x431 from Autobus V30	3.65	.553	Agreed
5	Identifying of the Data Link Connection (DLC) in OBD II compliant vehicles	3.28	.954	Agreed
6	Lunching of x431 to diagnose and read Digital Trouble Codes	2.96	.863	Agreed
7	Ability to use Lunch x431 to clear low Digital Trouble Codes	3.79	.544	Agreed
8	Lunching of x431 to read data streams	2.97	1.018	Agreed

9	Ability to use Lunch x431 to create repair files and access maintenance data via internet	3.59	.669	Agreed
10	Ability to use Lunch x431 to analyse OBD II compliant vehicles systems	3.65	.597	Agreed
11	Ability to use Lunch x431 to tune OBD II compliant vehicles systems	3.71	.640	Agreed
12	Lunching of x431 to access the complete vehicle, including: drive line, chassis, body, and the networking/communication modules	3.56	.499	Agreed
13	Lunching of x431/Autobus V30 to print out diagnosis details for clients using OBD II compliant vehicles	3.44	.499	Agreed
14	Lunch of x431/Autobus V30 to make interact with REAL technicians oversees	3.56	.499	Agreed
15	Lunching of x431/Autobus V30 to access Powertrain, Chassis, Body Systems	3.44	.499	Agreed
16	Lunching of x431/Autobus V30 to perform Electronic Control Unit (ECU) coding/programming	3.56	.499	Agreed
17	Ability to use lunch x431/Autobus V30 to carry out updating operations of the Windows Operating System in-built	3.44	.499	Agreed
18	Ability to interpret live data graphic display using lunch x431/Autobus V30	3.30	.624	Agreed

19	Ability to use Autobus V30 Original Equipment Manufactures' (OEM)	3.34	.779	Agreed
20	Connecting of lunch x431/Autobus V30 to the OBD II compliant vehicle DLC port	3.70	.537	Agreed

N=80

$\bar{X}$= mean of the respondents

N_1 = motor vehicle mechanic masters

N_2= senior apprentice

SD = standard deviation of the respondents

Table 4.1 showed that the respondents agreed with all the items from 1 to 20. This is because none of the mean response was below 2.50 which was the beach mark of agreed on the 4-points response options. The standard deviation score ranged between 0.498 and 1.018. This showed that the responses of the motor vehicle mechanic masters and senior apprentice on the items were not divergent.

4.2 Research Question 2

What are the challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis?

Table 4.2: Mean responses of motor vehicle mechanic masters and senior apprentice the challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

		N_1= 20		N_2=60
S/N	ITEMS	$\bar{X}$	**SD**	Remark
1	Lack of knowledge of the use of computer	3.79	.544	Agreed
2	Lack of formal education	2.97	1.018	Agreed
3	Lack of knowledge of trouble shooting codes	3.51	.746	Agreed
4	Lack of the Knowledge of the use of internet	3.64	.601	Agreed
5	Most MVM lack the Knowledge of Electronic Control Unit (ECU)	3.66	.711	Agreed
6	Lack of the Ability to manage personal data and use online dictionary	3.59	.791	Agreed
7	Not ready to learn in order to improve relevant skills	3.72	.551	Agreed
8	Too much familiarity with trial and error method	3.64	.601	Agreed

N=80

$\bar{X}$= mean of the respondents

N_1 = motor vehicle mechanic masters

N_2= senior apprentice

SD = standard deviation of the respondents

Table 4.2 showed that the respondents agreed with all the items. This was because none of the mean response was below 2.50 which was the bench mark of agreed on the 4-point response options. The standard deviation score ranged between 0.544 and 1.018. This showed that the responses of the motor vehicle mechanic masters and senior apprentice on the items were not divergent.

4.3 Research Question 3

What are the strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis?

Table 4.3: Mean responses of motor vehicle mechanic masters and senior apprentice on the strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

N_1= 20 **N_2=60**

S/N	ITEMS	$\bar{X}$	SD	Remark
1	On-the job training	3.79	.544	Agreed
2	Creation of Weekend workshop training for MVM on the use of computerized diagnostics equipment	2.98	1.014	Agreed
3	National Automotive Council in collaboration with government to provide intense training	3.58	.671	Agreed
4	National Automotive Council to upskill MVM in OBD skills	3.64	.601	Agreed
5	National Automotive Council collaboration with	3.70	.644	Agreed

	tertiary institutions to arrange workshop and training			
6	National Automotive Council collaboration with foreign bodies for better improvement on various diagnostics approach	3.67	.671	Agreed
7	Adoption Distance learning methods	3.74	.545	Agreed
8	Mentoring methods	3.65	.597	Agreed
9	National Automotive Council in collaboration with Small and Medium Enterprises Development Agency of Nigeria	3.61	.646	Agreed
10	Roadside motor vehicle mechanics should enroll for mechatronic courses	3.31	.587	Agreed

N=80

$\bar{X}$= mean of the respondents

N_1 = motor vehicle mechanic masters

N_2= senior apprentice

SD = standard deviation of the respondents

Table 4.3 showed that the respondents agreed with all the items from 1 to 10. This was because none of the mean response was below 2.50 which was the bench mark of agreed on the 4-point response options. The standard deviation score ranged between 0.544 and 1.010. This showed that the responses of the industrial supervisors and the technical teachers on the items were not divergent.

4.4 Hypothesis 1

There is no significant difference in the mean responses of motor vehicle mechanic masters and senior apprentice on the challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

Table 4.4 T-test on challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

$N_1 = 20$ AND $N_2 = 60$

Respondents	N	X	SD	Df	Tcal	P-value	Remark
Motor Vehicle Mechanic Masters	20	3.60	.754	78	1.805	0.005	NS
Senior Apprentice	60	3.85	.444				

N=80

$\bar{X}_1$= mean of Motor Vehicle Mechanic Masters

$\bar{X}_2$ = mean of Senior Apprentice

N_1 = Motor Vehicle Mechanic Masters

N_2= Senior Apprentice

SD_1 = standard deviation of Motor Vehicle Mechanic Masters

SD_2 = standard deviation of Senior Apprentice

NS=Not Significant

Table 4.4 showed that there was no significant difference in the responses of Motor Vehicle Mechanic Masters and Senior Apprentice on all the items as challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in

Abuja metropolis; therefore the null hypothesis of no significant difference was upheld at 0.05 level of significance.

Findings of the study

The following are the main findings of the study; they are prepared based on the research questions and hypothesis tested.

Skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis

- Ability to identify Lunch x431
- Ability to identify Autobus V30
- Identifying of necessary cables and adapters for both Lunch x431 and Autobus V30
- Ability to differentiate Lunch x431 from Autobus V30
- Identifying of the Data Link Connection (DLC) in OBD II compliant vehicles
- Lunching of x431 to diagnose and read Digital Trouble Codes
- Ability to use Lunch x431 to clear low Digital Trouble Codes
- Lunching of x431 to read data streams
- Ability to use Lunch x431 to create repair files and access maintenance data via internet
- Ability to use Lunch x431 to analyse OBD II compliant vehicles systems
- Ability to use Lunch x431 to tune OBD II compliant vehicles systems
- Lunching of x431 to access the complete vehicle, including: drive line, chassis, body, and the networking/communication modules
- Lunching of x431/Autobus V30 to print out diagnosis details for clients using OBD II compliant vehicles
- Lunch of x431/Autobus V30 to make interact with REAL technicians oversees
- Lunching of x431/Autobus V30 to access Powertrain, Chassis, Body Systems

- Lunching of x431/Autobus V30 to perform Electronic Control Unit (ECU) coding/programming
- Ability to use lunch x431/Autobus V30 to carry out updating operations of the Windows Operating System in-built
- Ability to interpret live data graphic display using lunch x431/Autobus V30
- Ability to use Autobus V30 Original Equipment Manufactures' (OEM)
- Connecting of lunch x431/Autobus V30 to the OBD II compliant vehicle DLC port

Challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

- Lack of knowledge of the use of computer
- Lack of formal education
- Lack of knowledge of trouble shooting codes
- Lack of the Knowledge of the use of internet
- Most MVM lack the Knowledge of Electronic Control Unit (ECU)
- Lack of the Ability to manage personal data and use online dictionary
- Not ready to learn in order to improve relevant skills
- Too much familiarity with trial and error method

Strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis

- On-the job training
- Creation of Weekend workshop training for MVM on the use of computerized diagnostics equipment
- National Automotive Council in collaboration with government to provide intense training

- National Automotive Council to upskill MVM in OBD skills
- National Automotive Council collaboration with tertiary institutions to arrange workshop and training
- National Automotive Council collaboration with foreign bodies for better improvement on various diagnostics approach
- Adoption Distance learning methods
- Mentoring methods
- National Automotive Council in collaboration with Small and Medium Enterprises Development Agency of Nigeria
- Roadside motor vehicle mechanics should enroll for mechatronic courses

Discussion of findings.

The result from table 4.1 shows the findings on the Skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis. The findings among others reveal the Ability to identify Lunch x431, Ability to identify Autobus V30, Identifying of necessary cables and adapters for both Lunch x431 and Autobus V30, Ability to differentiate Lunch x431 from Autobus V30, Identifying of the Data Link Connection (DLC) in OBD II compliant vehicles, Lunching of x431 to diagnose and read Digital Trouble Codes, Ability to use Lunch x431 to clear low Digital Trouble Codes, Lunching of x431 to read data streams, Ability to use Lunch x431 to create repair files and access maintenance data via internet, Ability to use Lunch x431 to analyse OBD II compliant vehicles systems, Ability to use Lunch x431 to tune OBD II compliant vehicles systems, Lunching of x431 to access the complete vehicle, including: drive line, chassis, body, and the networking/communication modules, Lunching of x431/Autobus V30 to print out diagnosis details for clients using OBD II compliant vehicles, Lunch of x431/Autobus V30 to make interact with REAL technicians oversees, Lunching of x431/Autobus V30 to access

Powertrain, Chassis, Body Systems, Lunching of x431/Autobus V30 to perform Electronic Control Unit (ECU) coding/programming, Ability to use lunch x431/Autobus V30 to carry out updating operations of the Windows Operating System in-built, Ability to interpret live data graphic display using lunch x431/Autobus V30, Ability to use Autobus V30 Original Equipment Manufactures' (OEM), Connecting of lunch x431/Autobus V30 to the OBD II compliant vehicle DLC port. MVM require adequate skills in other to properly utilized computerized diagnostic equipment for troubleshooting modern car. The finding of this study is in line with Edunyah (2015) who observed that most motor vehicle mechanics seem not to be able to use most automotive digital diagnostic tools for diagnosis, repair and maintenance of modern vehicles but seem to be aware of some basics computer skills for effective manipulation of automotive digital diagnostic tools.

Table 4.2 reveal the result of the findings on the Challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis. The findings among other reveal that Lack of knowledge of the use of computer, Lack of formal education, Lack of knowledge of trouble shooting codes, Lack of the Knowledge of the use of internet, Most MVM lack the Knowledge of Electronic Control Unit (ECU), Lack of the Ability to manage personal data and use online dictionary, Not ready to learn in order to improve relevant skills, Too much familiarity with trial and error method. The result of the findings shows that a lot of MVM encounter series of challenges in the use of computerized diagnostic tools troubleshooting modern car. The findings of the study corroborated with the report of Opeyemi and Benjamin (2020) which indicates most roadside motor vehicle mechanics lack the basic computer skills required for the effective manipulation of automotive digital diagnostic tools. It is also in line with Maigida and Francis (2014) cited in Opeyemi and Benjamin (2020) who noted that most roadside motor vehicle mechanics do not possess the required basic computer skills for the effective manipulation of automotive digital diagnostic tools and this has further worsened the satiation for them as numerous sensors and actuators are now incorporated in modern vehicles.

The result of the hypothesis on the challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis shows that there was no significant difference in the responses of motor vehicle mechanic masters and senior apprentice on all the items as challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis.

The result from table 4.3 reveal the findings on Strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis. The findings of the study reveal that there should be On-the job training, Creation of Weekend workshop training for MVM on the use of computerized diagnostics equipment, National Automotive Council in collaboration with government to provide intense training, National Automotive Council to upskill MVM in OBD skills, National Automotive Council collaboration with tertiary institutions to arrange workshop and training, National Automotive Council collaboration with foreign bodies for better improvement on various diagnostics approach, Adoption Distance learning methods, Mentoring methods, National Automotive Council in collaboration with Small and Medium Enterprises Development Agency of Nigeria, Roadside motor vehicle mechanics should enroll for mechatronic courses. This connote that stakeholders concerned with ensuring roadside motor vehicle mechanics are provided with the relevant technical skills and cognitive skills in the use of automotive digital diagnostic tools of international standard should ensure the implementation of training and retraining programmes for roadside motor vehicle mechanics to enable them effectively handle modern vehicles in Nigeria. Roner (2018) who noted that automotive systems are very different from the automotive systems of thirty years ago. Hence, today's roadside motor vehicle mechanics require a large amount of education and training strategies on each automotive system to develop the high-level diagnostic troubleshooting skills needed to work on today's automotive technologies.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the Study

The main focus of this research study was to find out the challenges to the effective utilization of computerized diagnostics equipment by motor vehicle mechanic for troubleshooting modern car in Abuja metropolis

Chapter 1 of the study discussed the background of the study, the statement of problem, purpose, significance, scope and the research questions were all stated and discussed for the conduct of this research.

The review of related literature looked into History of Motor Vehicles in Nigeria, Electronic Engine Management System, On-Board Diagnostic (OBD) Software, On- Board Diagnostic Tools, Diagnostic Trouble Codes and Fault Codes, Skills requirements of roadside mechanics. Various views of different authors concerning the topic were harmonized in a comprehensive literature review and empirical studies.

A survey approach was used to developed instrument for the study; the respondents identified as the population of the study were the motor vehicle mechanic masters and senior apprentice. The entire respondents were used. A number of 80 questionnaires were administered. The instrument used was analysed using frequency count, and mean scores. The research questions were discussed base on the findings from the responses and results of the instrument used.

Implication of the study and conclusions were also drawn from the findings discussed. Recommendations and suggestions for further study were formulated and stated according to the findings of the study

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5.2 Implication of the Study

The findings of the study had implications for government, artisans and MVMW students. From the outcome of the study, it implies that If the identified areas where collaboration between automobile manufacturing industries and MVM in other to equip the MVM on modern ways of dragonizing computerized vehicles.

Conclusion

Based on the findings of the study, the following conclusions were drawn: some basic computer skills required for the automotive digital diagnostic tools but seriously lack the skills required to manipulate them for diagnosis, repair and maintenance of modern vehicles. One of the reasons for this as noted by Roner is the lack of training programmes organized for these set of individuals to become stable in handling these automotive digital diagnostic tools for effective repairs of modern vehicles. To this end, it therefore mean that efforts should be made by stakeholders in the direction of not just planning but as well implementing a realistic training programme where roadside motor vehicle mechanics who want it, need it and can make profit by it, can be trained thereby enabling them acquire and possibly develop modern work skills of international standard needed for the effective repair and maintenance of modern vehicles as found in Nigeria today, thus boosting their job performance and satisfaction, daily customer patronage as well in the efficient handling of simple and complex faults on modern vehicles using recent automotive digital diagnostic tools

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Stakeholders who are saddled with the job of ensuring standards in automotive diagnosis, repair and maintenance in Nigeria should collaborate with leaders of roadside motor vehicle mechanics so as to develop appropriate strategies for training and retraining them on the in-depth knowledge of recent technologies needed for the manipulation of automotive digital diagnostic tools used to repair modern vehicle.

2. Federal Government of Nigeria, Automobile manufacturers and industries should collaborate with educational institutions to organize skill improvement training programmes for MVM on the identified knowledge and computer diagnostic skills.
3. MVMW craftsmen, automobile technicians and artisans should acquire enough computer knowledge especially in relation to automobile maintenance in order to keep pace with technological advancement.

Suggestion for Further Study

The following are suggested for further studies:

1. Emerging technology skills required in the maintenance modern vehicles in modern systems of the automobile.
2. Integration of computer diagnostic skills into the curriculum contents of MVMW programme in technical colleges.
3. Strategies for skill improvement training of technical teachers on emerging technologies for effective teaching and learning of MVMW in technical colleges.

Reference

Adamu, S. O. (2018). *The impact of information and communication technology in teaching and learning in Enugu-East local government area of Enugu state* (Doctoral dissertation, Adamu Samuel Ojonuba).

Aganga, O. (2013). *New Auto Policy is Ready*. Retrieved May 7, 2020, from The Punch Nigeria: http://www.punchng.com/business/industry

Akaigwe. (2010). Auto industry @ 50. *Nigerian Journal of Engineering Science*.

Alabi, J. O., Idris, A. M., & Owodunni, A. S. (2019). Core On-Board Diagnostic Skills Required by Motor Vehicle Mechanics for Troubleshooting Engine Performance and Transmission System of Modern Automotive in Niger State. *mechanics*.

Auto repair Business and Trends, (2012). Auto repair Business Industry summary.Breau of Labour statistics USA.

Baraniello, V., Degano, C., Laura, L., Zahonero, M. L., Naldi, M., & Petroni, S. (2016). A wiki-based approach to computer-assisted translation for collaborative language learning. In *State-of-the-Art and Future Directions of Smart Learning* (pp. 369-379). Springer, Singapore.

Camp, W. G. (1983). Social efficiency and vocational education: An examination of our changing philosophies. Journal of Vocational Education Research 8(3), 10-19.

Chamberlain, O., & Ede, E. (2013). History of automobile past and present challenges facing automobile production in Nigeria. *Journal of Research and Methods in Education*, *2*(4), 11-16.

Chen, S., Dai, F., & Cai, M. (2020). Opportunities and challenges of high-energy lithium metal batteries for electric vehicle applications. *ACS energy letters*, *5*(10), 3140-3151.

Edunyah, I. (2015). Technology and Modern Automobile Industry-Challenges and Opportunities for Roadside Mechanics in Ghana.(TarkwaNsueam Municipality). International Journal of Scientific Research and Innovative Technology, 2(6), 58-63.

Funkhouser, J. (2013). How innovation has changed the job of auto repair technician. Washington Post.

Jalal, D. (2013). enhance capacity building in line with the approved National Automotive Industry Development Plan. Nigeria: Houton best new.

Jeffrey, N. R. (2015). 40-millionth Toyota Corolla ever built. Autoblog.com. Retrieved 2015-02-17.

Kayemuddin, M., &Kayum, S. (2013).Problems and prospects of automobile workshops in Bangladesh.Journal of African Studies and Development, 5(6), 157.

Kinyanjui M. N. (2000). Tappingopportunities in jua kali enterprises clusters: The case of Ziwani and Kigandain.Nairob. European Centre for Research Training and Development UK.

Lindsay, C. (2013). How car will get more helpful. Available on: www.autocar.com. Retrieved fromwww.autorcar.com.

McLeod,S.A.(2014).SamplingMethods.Retrivedfromwww.simplypsychology.org/samplig.html

Nandhini, A., & Devi, D. P. (2014). Error Reduction in WiMAX Deinterleaver Address Generator by Using Majority Logic Circuit.

Okogba, F.I. (1991). Vocational education and the informal system. Nigerian Vocational Journal,2(4) 1–6.

Okuhit, J. (2015). Sweet New Vehicles. *Huge Maintenance Cost*.

Oluwatimilehin, A. S., Chimezia, U. K., & Danladi, M. (2021). Integration of Automobile Mechatronics Technology into the Curriculum of Automobile Trades Programmes at the Technical Colleges in Nigeria. *Randwick International of Education and Linguistics Science Journal*, *2*(1), 20-28.

Oni, C. S. (2006). Vocationalism in Nigerian Education. Journal of Social Science, 12(2): 147-150.

Opeyemi, O. O., & Benjamin, U. O. (2020). Strategies for Enhancing Roadside Motor Vehicle Mechanics on Basic Computer Skills for Effective Manipulation of Automotive Digital Diagnostic Tools in Nsukka Urban of Enugu State. *American Journal of Mechanical and Industrial Engineering*, *5*(6), 71-77.

Otis , K. (2007). Skills Every Auto Mechanic Should Have. Wyo Tech**.**

Ribbens, W. B. (2003). understanding automotive electronics fifth edition. New York: Elsevier Science .pp.470.

Roner, N. (2018). Optimum Suspension Geometry for a Formula SAE Car.

Sambo, M. N., Idris, S. H., &Shamang, A. (2012).Determinants of occupational health hazards among roadside automobile mechanics in Zaria, North Western Nigeria.Borno Medical Journal, 9(1), 5-9.

Santini, A. (2004). automotive electronic 2nd edition.Glen Ellyn, Illinois: Cengage Learning.pp.544.

Uwameiye, R. &Omofonmwan, G. (2014).The perceived objectives of roadside mechanic apprenticeship programs in mid-western Nigeria. Australian Journal of Adult Learning.vol.44(1)86-90.

Ziblim, B., Nkrumah, J., & Imoro, I. (2018). Assessing the Skills of Roadside Mechanics in Diagnosing and Fixing Problems of Modern Electronic Managed Vehicles in Ghana (Tamale Metropolis). *American Academic Scientific Research Journal for Engineering, Technology, and Sciences*, *45*(1), 207-225.

APPENDIX A

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

A QUESTIONNAIRE ON THE CHALLENGES TO THE EFFECTIVE UTILIZATION OF COMPUTERIZED DIAGNOSTICS EQUIPMENT BY MOTOR VEHICLE MECHANIC FOR TROUBLESHOOTING MODERN CAR IN ABUJA METROPOLIS

INTRODUCTION: Please kindly complete this questionnaire by ticking the column that best present your perception about the topic. The questionnaire is for research purpose and your view will be confidentially and strictly treated in response to the purpose of the research work.

SECTION A

PERSONAL DATA

Motor Vehicle Mechanic Masters: ☐

Senior Apprentice: ☐

Note: A four (4) point scale is used to indicate your opinion, tick the options which best describe your agreement as shown below:

Strongly Agree	(SA)	=	4 points
Agree	(A)	=	3 points
Disagree	(D)	=	2 points
Strongly Disagree	(SD)	=	1 point

Section B: What are the skills required by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis?

S/N	Items	Scales			
		SA	A	SD	D
1	Ability to identify Lunch x431				
2	Ability to identify Autobus V30				
3	Identifying of necessary cables and adapters for both Lunch x431 and Autobus V30				
4	Ability to differentiate Lunch x431 from Autobus V30				
5	Identifying of the Data Link Connection (DLC) in OBD II compliant vehicles				
6	Lunching of x431 to diagnose and read Digital Trouble Codes				
7	Ability to use Lunch x431 to clear low Digital Trouble Codes				
8	Lunching of x431 to read data streams				
9	Ability to use Lunch x431 to create repair files and access maintenance data via internet				
10	Ability to use Lunch x431 to analyse OBD II compliant vehicles systems				
11	Ability to use Lunch x431 to tune OBD II compliant vehicles systems				
12	Lunching of x431 to access the complete vehicle, including: drive line, chassis, body, and the networking/communication modules				
13	Lunching of x431/Autobus V30 to print out diagnosis details for clients using OBD II compliant vehicles				
14	Lunch of x431/Autobus V30 to make interact with REAL technicians oversees				
15	Lunching of x431/Autobus V30 to access Powertrain, Chassis, Body Systems				
16	Lunching of x431/Autobus V30 to perform Electronic Control Unit (ECU) coding/programming				
17	Ability to use lunch x431/Autobus V30 to carry out updating operations of the Windows Operating System in-built				
18	Ability to interpret live data graphic display using lunch x431/Autobus V30				

19	Ability to use Autobus V30 Original Equipment Manufactures' (OEM)				
20	Connecting of lunch x431/Autobus V30 to the OBD II compliant vehicle DLC port				

Section C: What are the challenges faced by MVM in effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis?

S/N	Items	Scales			
		SA	A	SD	D
1	Lack of knowledge of the use of computer				
2	Lack of formal education				
3	Lack of knowledge of trouble shooting codes				
4	Lack of the Knowledge of the use of internet				
5	Most MVM lack the Knowledge of Electronic Control Unit (ECU)				
6	Lack of the Ability to manage personal data and use online dictionary				
7	Not ready to learn in order to improve relevant skills				
8	Too much familiarity with trial and error method				

Section D: What are the strategies for enhancing effective utilization of computerized diagnostics equipment for troubleshooting modern car in Abuja metropolis?

S/N	Skill Items	Scale			
		SA	A	SD	D
1	On-the job training				
2	Creation of Weekend workshop training for MVM on the use of computerized diagnostics equipment				
3	National Automotive Council in collaboration with government to provide intense training				
4	National Automotive Council to upskill MVM in OBD skills				

5	National Automotive Council collaboration with tertiary institutions to arrange workshop and training				
6	National Automotive Council collaboration with foreign bodies for better improvement on various diagnostics approach				
7	Adoption Distance learning methods				
8	Mentoring methods				
9	National Automotive Council in collaboration with Small and Medium Enterprises Development Agency of Nigeria				
10	Roadside motor vehicle mechanics should enroll for mechatronic courses				

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Q16 Q17 Q18 Q19 Q20
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Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Q1	80	2	4	3.71	.508
Q2	80	1	4	3.79	.567
Q3	80	1	4	3.79	.544
Q4	80	2	4	3.65	.553
Q5	80	1	4	3.28	.954
Q6	80	1	4	2.96	.863
Q7	80	1	4	3.79	.544
Q8	80	1	4	2.97	1.018
Q9	80	1	4	3.59	.669
Q10	80	1	4	3.65	.597
Q11	80	1	4	3.71	.640
Q12	80	3	4	3.56	.499
Q13	80	3	4	3.44	.499
Q14	80	3	4	3.56	.499
Q15	80	3	4	3.44	.499
Q16	80	3	4	3.56	.499
Q17	80	3	4	3.44	.499
Q18	80	1	4	3.30	.624
Q19	80	1	4	3.34	.779
Q20	80	2	4	3.70	.537
Valid N (listwise)	80				

Group Statistics

	RESPONDENTS	N	Mean	Std. Deviation	Std. Error Mean
Q1	MOTOR VEHICLE MECHANIC MASTER	20	3.75	.444	.099
	SENIOR APPRENTICE	60	3.70	.530	.068
Q2	MOTOR VEHICLE MECHANIC MASTER	20	4.00	.000	.000
	SENIOR APPRENTICE	60	3.72	.640	.083
Q3	MOTOR VEHICLE MECHANIC MASTER	20	4.00	.000	.000
	SENIOR APPRENTICE	60	3.72	.613	.079
Q4	MOTOR VEHICLE MECHANIC MASTER	20	4.00	.000	.000
	SENIOR APPRENTICE	60	3.53	.596	.077
Q5	MOTOR VEHICLE MECHANIC MASTER	20	2.40	.940	.210
	SENIOR APPRENTICE	60	3.57	.767	.099
Q6	MOTOR VEHICLE MECHANIC MASTER	20	1.95	.224	.050
	SENIOR APPRENTICE	60	3.30	.720	.093

Q7	MOTOR VEHICLE MECHANIC MASTER	20	3.90	.447	.100
	SENIOR APPRENTICE	60	3.75	.571	.074
Q8	MOTOR VEHICLE MECHANIC MASTER	20	2.90	.447	.100
	SENIOR APPRENTICE	60	3.00	1.150	.148
Q9	MOTOR VEHICLE MECHANIC MASTER	20	3.85	.489	.109
	SENIOR APPRENTICE	60	3.50	.701	.091
Q10	MOTOR VEHICLE MECHANIC MASTER	20	3.70	.801	.179
	SENIOR APPRENTICE	60	3.63	.520	.067
Q11	MOTOR VEHICLE MECHANIC MASTER	20	3.80	.523	.117
	SENIOR APPRENTICE	60	3.68	.676	.087
Q12	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.513	.115
	SENIOR APPRENTICE	60	3.58	.497	.064
Q13	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.513	.115
	SENIOR APPRENTICE	60	3.42	.497	.064
Q14	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.513	.115
	SENIOR APPRENTICE	60	3.58	.497	.064
Q15	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.513	.115
	SENIOR APPRENTICE	60	3.42	.497	.064
Q16	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.513	.115
	SENIOR APPRENTICE	60	3.58	.497	.064
Q17	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.513	.115
	SENIOR APPRENTICE	60	3.42	.497	.064
Q18	MOTOR VEHICLE MECHANIC MASTER	20	2.95	.510	.114
	SENIOR APPRENTICE	60	3.42	.619	.080
Q19	MOTOR VEHICLE MECHANIC MASTER	20	3.40	.598	.134
	SENIOR APPRENTICE	60	3.32	.833	.108
Q20	MOTOR VEHICLE MECHANIC MASTER	20	4.00	.000	.000
	SENIOR APPRENTICE	60	3.60	.588	.076

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Q1	Equal variances assumed	0.835	0.364	0.379	78	0.706	0.050	0.132	-0.213	0.313
	Equal variances not assumed			0.414	38.544	0.681	0.050	0.121	-0.194	0.294

Q2	Equal variances assumed	20.286	0.000	1.971	78	0.052	0.283	0.144	-0.003	0.570
	Equal variances not assumed			3.428	59.000	0.001	0.283	0.083	0.118	0.449
Q3	Equal variances assumed	22.250	0.000	2.058	78	0.043	0.283	0.138	0.009	0.557
	Equal variances not assumed			3.579	59.000	0.001	0.283	0.079	0.125	0.442
Q4	Equal variances assumed	110.164	0.000	3.489	78	0.001	0.467	0.134	0.200	0.733
	Equal variances not assumed			6.069	59.000	0.000	0.467	0.077	0.313	0.621
Q5	Equal variances assumed	4.386	0.039	-5.559	78	0.000	-1.167	0.210	-1.584	-0.749
	Equal variances not assumed			-5.020	27.926	0.000	-1.167	0.232	-1.643	-0.691
Q6	Equal variances assumed	44.323	0.000	-8.221	78	0.000	-1.350	0.164	-1.677	-1.023
	Equal variances not assumed			-12.788	77.843	0.000	-1.350	0.106	-1.560	-1.140
Q7	Equal variances assumed	4.054	0.048	1.069	78	0.289	0.150	0.140	-0.129	0.429
	Equal variances not assumed			1.207	41.345	0.234	0.150	0.124	-0.101	0.401
Q8	Equal variances assumed	18.160	0.000	-0.378	78	0.706	-0.100	0.264	-0.626	0.426
	Equal variances not assumed			-0.559	76.059	0.578	-0.100	0.179	-0.456	0.256
Q9	Equal variances assumed	12.144	0.001	2.067	78	0.042	0.350	0.169	0.013	0.687
	Equal variances not assumed			2.465	46.833	0.017	0.350	0.142	0.064	0.636

Q10	Equal variances assumed	0.140	0.709	0.430	78	0.668	0.067	0.155	-0.242	0.375
	Equal variances not assumed			0.348	24.545	0.730	0.067	0.191	-0.328	0.461
Q11	Equal variances assumed	1.888	0.173	0.703	78	0.484	0.117	0.166	-0.214	0.447
	Equal variances not assumed			0.799	41.878	0.429	0.117	0.146	-0.178	0.411
Q12	Equal variances assumed	0.557	0.458	-0.644	78	0.521	-0.083	0.129	-0.341	0.174
	Equal variances not assumed			-0.634	31.757	0.531	-0.083	0.131	-0.351	0.184
Q13	Equal variances assumed	0.557	0.458	0.644	78	0.521	0.083	0.129	-0.174	0.341
	Equal variances not assumed			0.634	31.757	0.531	0.083	0.131	-0.184	0.351
Q14	Equal variances assumed	0.557	0.458	-0.644	78	0.521	-0.083	0.129	-0.341	0.174
	Equal variances not assumed			-0.634	31.757	0.531	-0.083	0.131	-0.351	0.184
Q15	Equal variances assumed	0.557	0.458	0.644	78	0.521	0.083	0.129	-0.174	0.341
	Equal variances not assumed			0.634	31.757	0.531	0.083	0.131	-0.184	0.351
Q16	Equal variances assumed	0.557	0.458	-0.644	78	0.521	-0.083	0.129	-0.341	0.174
	Equal variances not assumed			-0.634	31.757	0.531	-0.083	0.131	-0.351	0.184
Q17	Equal variances assumed	0.557	0.458	0.644	78	0.521	0.083	0.129	-0.174	0.341
	Equal variances not assumed			0.634	31.757	0.531	0.083	0.131	-0.184	0.351

Q18	Equal variances assumed	20.691	0.000	-3.042	78	0.003	-0.467	0.153	-0.772	-0.161
	Equal variances not assumed			-3.350	39.144	0.002	-0.467	0.139	-0.748	-0.185
Q19	Equal variances assumed	1.725	0.193	0.412	78	0.681	0.083	0.202	-0.319	0.486
	Equal variances not assumed			0.485	45.416	0.630	0.083	0.172	-0.262	0.429
Q20	Equal variances assumed	75.759	0.000	3.029	78	0.003	0.400	0.132	0.137	0.663
	Equal variances not assumed			5.269	59.000	0.000	0.400	0.076	0.248	0.552

```
Your temporary usage period for IBM SPSS Statistics will expire in 4688
days.
```

```
GET DATA
  /TYPE=XLSX
  /FILE='C:\Users\USER\Desktop\New folder (2)\OBD TOOL\Excel Analysis.xlsx'
  /SHEET=name 'R2'
  /CELLRANGE=FULL
  /READNAMES=ON
  /DATATYPEMIN PERCENTAGE=95.0
  /HIDDEN IGNORE=YES.
EXECUTE.
DATASET NAME DataSet1 WINDOW=FRONT.
DESCRIPTIVES VARIABLES=Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Q1	80	1	4	3.79	.544
Q2	80	1	4	2.97	1.018
Q3	80	1	4	3.51	.746
Q4	80	1	4	3.64	.601
Q5	80	1	4	3.66	.711
Q6	80	1	4	3.59	.791
Q7	80	2	4	3.72	.551
Q8	80	2	4	3.64	.601
Valid N (listwise)	80				

Group Statistics

	RESPONDENTS	N	Mean	Std. Deviation	Std. Error Mean

Q1	MOTOR VEHICLE MECHANIC MASTER	20	3.60	.754	.169
	SENIOR APPRENTICE	60	3.85	.444	.057
Q2	MOTOR VEHICLE MECHANIC MASTER	20	3.10	1.119	.250
	SENIOR APPRENTICE	60	2.93	.989	.128
Q3	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.761	.170
	SENIOR APPRENTICE	60	3.52	.748	.097
Q4	MOTOR VEHICLE MECHANIC MASTER	20	3.55	.605	.135
	SENIOR APPRENTICE	60	3.67	.601	.078
Q5	MOTOR VEHICLE MECHANIC MASTER	20	3.60	.821	.184
	SENIOR APPRENTICE	60	3.68	.676	.087
Q6	MOTOR VEHICLE MECHANIC MASTER	20	3.65	.587	.131
	SENIOR APPRENTICE	60	3.57	.851	.110
Q7	MOTOR VEHICLE MECHANIC MASTER	20	3.75	.444	.099
	SENIOR APPRENTICE	60	3.72	.585	.076
Q8	MOTOR VEHICLE MECHANIC MASTER	20	3.60	.503	.112
	SENIOR APPRENTICE	60	3.65	.633	.082

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Q1	Equal variances assumed	8.510	0.005	-1.805	78	0.075	-0.250	0.139	-0.526	0.026
	Equal variances not assumed			-1.404	23.553	0.173	-0.250	0.178	-0.618	0.118
Q2	Equal variances assumed	1.553	0.216	0.631	78	0.530	0.167	0.264	-0.359	0.692
	Equal variances not assumed			0.593	29.538	0.558	0.167	0.281	-0.408	0.741
Q3	Equal variances assume	0.128	0.721	-0.086	78	0.932	-0.017	0.194	-0.403	0.369

	d									
	Equal variances not assumed			-0.085	32.128	0.933	-0.017	0.196	-0.415	0.382
Q4	Equal variances assumed	0.517	0.474	-0.750	78	0.455	-0.117	0.155	-0.426	0.193
	Equal variances not assumed			-0.748	32.449	0.460	-0.117	0.156	-0.434	0.201
Q5	Equal variances assumed	0.709	0.402	-0.452	78	0.653	-0.083	0.184	-0.450	0.284
	Equal variances not assumed			-0.410	28.108	0.685	-0.083	0.203	-0.500	0.333
Q6	Equal variances assumed	1.566	0.215	0.406	78	0.686	0.083	0.205	-0.325	0.492
	Equal variances not assumed			0.487	47.439	0.629	0.083	0.171	-0.261	0.428
Q7	Equal variances assumed	0.597	0.442	0.233	78	0.816	0.033	0.143	-0.251	0.318
	Equal variances not assumed			0.267	42.706	0.791	0.033	0.125	-0.218	0.285
Q8	Equal variances assumed	0.162	0.689	-0.321	78	0.749	-0.050	0.156	-0.360	0.260
	Equal variances not assumed			-0.360	40.743	0.721	-0.050	0.139	-0.331	0.231

```
DESCRIPTIVES VARIABLES=Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation

Q1	80	1	4	3.79	.544
Q2	80	1	4	2.98	1.014
Q3	80	1	4	3.58	.671
Q4	80	1	4	3.64	.601
Q5	80	1	4	3.70	.644
Q6	80	1	4	3.67	.671
Q7	80	2	4	3.74	.545
Q8	80	2	4	3.65	.597
Q9	80	1	4	3.61	.646
Q10	80	2	4	3.31	.587
Valid N (listwise)	80				

Group Statistics

	RESPONDENTS	N	Mean	Std. Deviation	Std. Error Mean
Q1	MOTOR VEHICLE MECHANIC MASTER	20	3.70	.571	.128
	SENIOR APPRENTICE	60	3.82	.537	.069
Q2	MOTOR VEHICLE MECHANIC MASTER	20	3.80	.410	.092
	SENIOR APPRENTICE	60	2.70	1.013	.131
Q3	MOTOR VEHICLE MECHANIC MASTER	20	3.50	.761	.170
	SENIOR APPRENTICE	60	3.60	.643	.083
Q4	MOTOR VEHICLE MECHANIC MASTER	20	3.80	.410	.092
	SENIOR APPRENTICE	60	3.58	.645	.083
Q5	MOTOR VEHICLE MECHANIC MASTER	20	3.40	.754	.169
	SENIOR APPRENTICE	60	3.80	.576	.074
Q6	MOTOR VEHICLE MECHANIC MASTER	20	3.55	.759	.170
	SENIOR APPRENTICE	60	3.72	.640	.083
Q7	MOTOR VEHICLE MECHANIC MASTER	20	3.75	.444	.099
	SENIOR APPRENTICE	60	3.73	.578	.075
Q8	MOTOR VEHICLE MECHANIC MASTER	20	3.80	.410	.092
	SENIOR APPRENTICE	60	3.60	.643	.083
Q9	MOTOR VEHICLE MECHANIC MASTER	20	3.45	.686	.153
	SENIOR APPRENTICE	60	3.67	.629	.081
Q10	MOTOR VEHICLE MECHANIC MASTER	20	3.70	.470	.105
	SENIOR APPRENTICE	60	3.18	.567	.073

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Q1	Equal variances assumed	1.564	0.215	-0.829	78	0.410	-0.117	0.141	-0.397	0.164
	Equal variances not assumed			-0.803	30.955	0.428	-0.117	0.145	-0.413	0.180
Q2	Equal variances assumed	12.202	0.001	4.711	78	0.000	1.100	0.234	0.635	1.565
	Equal variances not assumed			6.883	74.981	0.000	1.100	0.160	0.782	1.418
Q3	Equal variances assumed	0.324	0.571	-0.575	78	0.567	-0.100	0.174	-0.446	0.246
	Equal variances not assumed			-0.528	28.603	0.601	-0.100	0.189	-0.487	0.287
Q4	Equal variances assumed	7.070	0.010	1.406	78	0.164	0.217	0.154	-0.090	0.523
	Equal variances not assumed			1.748	51.893	0.086	0.217	0.124	-0.032	0.465
Q5	Equal variances assumed	7.934	0.006	-2.482	78	0.015	-0.400	0.161	-0.721	-0.079
	Equal variances not assumed			-2.171	26.796	0.039	-0.400	0.184	-0.778	-0.022
Q6	Equal variances assumed	2.457	0.121	-0.962	78	0.339	-0.167	0.173	-0.512	0.178
	Equal variances not assumed			-0.883	28.560	0.385	-0.167	0.189	-0.553	0.220
Q7	Equal variances assumed	0.320	0.573	0.118	78	0.907	0.017	0.142	-0.265	0.299

	Equal variances not assumed			0.134	42.192	0.894	0.017	0.124	-0.234	0.267
Q8	Equal variances assumed	7.887	0.006	1.302	78	0.197	0.200	0.154	-0.106	0.506
	Equal variances not assumed			1.616	51.682	0.112	0.200	0.124	-0.048	0.448
Q9	Equal variances assumed	1.485	0.227	-1.304	78	0.196	-0.217	0.166	-0.547	0.114
	Equal variances not assumed			-1.248	30.357	0.222	-0.217	0.174	-0.571	0.138
Q10	Equal variances assumed	0.034	0.854	3.670	78	0.000	0.517	0.141	0.236	0.797
	Equal variances not assumed			4.033	38.956	0.000	0.517	0.128	0.258	0.776