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AUTOMOTIVE DIAGNOSTIC SKILLS NEEDED BY SERVICE TECHNICIANS IN THE MAINTENANCE OF MODERN VEHICLES IN BAUCHI STATE, NIGERIA

ALIYU BALALI ALIYU; ISMAIL Y SHEHU; & ABUBAKAR S ADAMU

Department of Vocational and Technology Education, Faculty of Technology Education, Abubakar Tafawa Balewa University Bauchi.

ABSTRACT

Modern vehicles' maintenance poses a great challenge to the Automobile service Technicians in the whole nation particularly in Bauchi state. As technology improves on the manufacturing process of modern vehicle the jobs and skills required by service technicians also changed. The study was to investigate the automotive diagnostic skills needed by service technicians in the maintenance of modern vehicles in Bauchi state Nigeria. The study setup two objectives which constituted the components of the research questions, based on the problems at hand. Some relevant literatures were reviewed, the design of the study adopted explanatory sequential mixed method research design. 188 service technicians were formed the sampled population of the study and 3 experts further selected for the second phase of the study. Purposive sampling was used in the study. A structured Automotive Diagnostic Skills Needed (ADSN) questionnaire and semi-structured were used in data collection. The collected data were analysed using mean/standard deviation and thematic analysis on the second phase. The result revealed the importance of western knowledge especially in fault detection. Which involves checking the previous work done record, familiar with dashboard indicator and signs. Knowledge of Electronic Control Module (ECM), OnBoard Diagnosis (OBD) systems and Diagnostic Trouble Codes (DTCS). However some of the recommendations are; Service technicians must undergo western education, that would enable him/her read and write with understanding if possible communicate fluently. And also, the Master

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Service technicians should strived to equip younger technicians with adequate knowledge and skills on handling and manipulation of modern diagnostic tools particularly OBD II scanners.

Keywords: Automotive Diagnostic, Modern Vehicles and Service Technicians.

Introduction

Today's modern vehicles' maintenance poses a great challenge to the Automobile service Technicians in the whole nation particularly in Bauchi state. Service technicians are faced with new challenges in new systems and methods of testing, diagnosing, measuring different values in the maintenance of modern vehicles.

(ConsuLab 2018). The advancement of ICT begot modern automotive technology as it affected automobile service technicians. As technology improves on the manufacturing process of modern vehicle the jobs and skills required by service technicians also changed (Ezeama, Obe and Ede 2016). Furthermore, technology innovation on the modern automobile have brought about comfort, safety, smoother operation, less fuel consumption, less or even zero emission and higher efficiency. Lanigan, *et al* (2011), also confirm that automotive systems consists of mechanical, hydraulic, software and hardware components and there is a staggering amount of embedded computing within automotive systems . For instance, current General Motors (GM) vehicles contain dozens of microprocessors and dozens of megabytes of software. These can be seen from its transitional development as a horse driven cart to horseless carriage to our present autonomous vehicle.

Autonomous vehicles, also known as computer intelligence vehicles, driverless vehicles and self-driving vehicles. According to Muh'd Faisal *et al* (2019), the basic concept of road vehicle automation, refers to the replacement of some or all of the human labour of driving, by electronics and or mechanical devices. Faisal *et al,* further describe that the origin of automated driving technology can be traced back to the early 20th century. At that time the technology was concentrated on autonomous speed, brake, lane control

and other basic cruise control aspect. Thus automotive evolution made faults diagnosis on modern vehicle extremely complex.

Automotive diagnosis is a process of detecting error or fault within a particular component or system of a vehicle. However, Halderman (2012), state that, the diagnosis process is a specific method of separating good components or parts in order to find the root cause of automotive problems. Holmes (2021) mention that, there are different types of diagnostics techniques in use today. These typically include computer tests, road tests, customer interviews, and basic problem-solving techniques. Thus prerequisites skills must be possessed by a service technicians for effective maintenance of modern vehicles.

Therefore, special tools, equipment and devices to perform such test and other diagnostic processes are of paramount important. Ezeama *et al* (2016) recommended that, facilities and resources such as computers, internet, scan tools, simulators and demonstrators are very important in the hands of trainers if motor vehicle mechanic training is to be embraced in earnest. Good troubleshooting of modern automotive in the word of Roner (2014), involves the ability of technicians to adopt diagnostic skills in retrieving DTCs as well as the use of a scan tool that communicates with the vehicle's on-board computer to access the OBD-II system in order to review history and affirm if it is a pending, current, or permanent fault, diagnose according to the steps in the repair manual. Thus means that service technician to performed such job, he/she must possess the required skills in the use of OBD scan tool and other diagnostic tools.

According to Opeyemi and Benjamin (2020) Over 70% of vehicles used in

Nigeria are imported from Europe, America and Asia through Nigeria Port Authority (NPA) or through Cotonou in neighbouring Benin Republic by foreign used vehicle dealers, independent sales men and individual buyers. These foreign used vehicles also known as "Tokunbo", are incorporates with electronic and computer related components called sensors and actuator switches can only be found in modern vehicles. Several studies have shown that service technicians encounter great difficulties trying to diagnose and repair simple faults in modern vehicles

Automotive Service Technicians in North-East Nigeria exhibited very low performance in diagnosing modern vehicles, particularly in Bauchi State. A study conducted by Inti,

Abdul Latib and Rufai (2014). Shown that Bauchi State Motor Vehicle Graduates demonstrated low level of technical skills in auto-electrical system maintenance, hence they are deficient in practical skills as a result of mismatch between technical college Motor Vehicle curriculum and the needs of the workplace in the maintenance and repairs of modern vehicles.

Therefore, Automobile technician requires a high level of diagnostic skills because of the increasing sophistication of the technology used in modern vehicle systems. The average vehicle may have 30 or more microprocessor-controlled devices (Motavalli, 2010 and Roner 2014). These electronic control units (ECU's), received signals from various sensors to feed vehicle system information to each ECU. The Powertrain Control Module (PCM) controls the operation of the engine and receives input from sensors that measure the crankshaft position and speed to determine fuel injection and spark timing. Olufemi *et al* (2019) state that, the era of depending solely on trial by error method and the mere experience of motor vehicle mechanics when troubleshooting various systems and subsystems is gradually coming to an end. Ziblima, Jacob and Issifu (2018) find out that, the job of an auto mechanic has become increasingly specialized in the 21st century, with the rapid advancement in technology. The job has evolved from purely mechanical to include electromechanical technology. Thus, automobile users require skilled automobile technicians for diagnosing a fault in their automobile maintenance, (Abubakar *et al* 2021). Roner (2014) also suggest that Today's automotive technicians require a large amount of education and training on each automotive system to develop the high-level diagnostic troubleshooting skills needed to work on today's automotive technologies. Diagnosis of car fault is a complicated process that demands a high level of knowledge and skills.

Theoretical Framework

A theory is a statement or an idea which explain a fact or an observation being made by someone (Adamu 2015). He mentioned that statement may take the form of functional definition, occupational, construct, assumption, postulations, hypothesis and generalization laws or theorem. Theory also could be seen as a set of interrelated concepts, definition and propositions that present a systematic views of phenomena by

specifying relation among variables with the purpose of exploring and predicting phenomena.

However, from the view of subsequent definition of theories. The Prosser's Theories found relevant to the Automotive Diagnostic Skills Needed by Service Technicians in Maintenance of Modern Vehicles. Among the sixteen prosser's theory of vocational training the following are found relevant to the study.

Firstly "Vocational training will be effective in proportion as the specific training experiences for forming right habits of doing and thinking are repeated to the point the habits developed are those of the finished skills necessary for gainful employment." This statement effects one of the most crucial requirement for successful vocational preparation. Few people could be prepared to perform skilfully some work without having spent sufficient time in performing the variety of skills required so that habit formation may take place to the end that they can practice these skills at a future date. The direct implication here is for adequate lengths of time during the day, and for an adequate period of time in months to cover the skill and technical development essential for effective employment as a productive worker.

Secondly "For every occupation there is a minimum of productive ability which an individual must possess in order to secure or retain employment in that occupation. If vocational education is not carried to that point with that individual, it is neither personally or socially effective." We see in the above statement a direct bearing upon the proficiency expected of learners who wish to find their place in the world of work. Vocational education must prepare the individual to meet the employment requirements of employers. Again, to meet these employment requirements requires considerable preparation, which relates to the length of the period, day or year required for the particular offering.

Thirdly "Vocational education must recognize conditions as they are and must train individuals to meet the demands of the "market" even though it may be true that more efficient ways of conducting the occupation may be known and that better working conditions are highly desirable." Vocational education programs can never exist as merely course in a school system but must be considered a community-wide project. Therefore, this statement implies the dire need for the use of craft committees; for

instructors with recent employment experience; and for a program that is geared to existing opportunities in the community, the area or the state. Instruction beyond immediate needs is encouraged, but not at the cost of basic current needs of employers.

Modern Vehicles

There are so many other technological advancement and features been introduced in to various system and subsystems of the modern vehicles; in order to improve comfort ability while driving in every condition; safety of the occupants and the vehicle itself; engine performance, fuel efficiency and emission control. Britanica (2021). Consequently, modern automotive engines possess a great number of different types of sensors, computer control units and actuators. Thus lead to partly or completely replacement of some systems operate mechanically or hydraulically in to electronically. Although, modern vehicles are the type of automobile complied with the OBD II protocols (1996 to present).

Automotive Sensors:

Sensors according to Williams J. Fleming (2008) can be defined as the devices that transduce physical quantities such as pressure or acceleration into electrical signals that serve as inputs for control systems. Engineering literature does not consistently differentiate between the terms, "sensors" and "transducers." Whether devices are called sensors or transducers often depends on the field of application in which they are used. In the automotive field, these devices are more commonly referred to as sensors. Sensors are essential components of automotive electronic control systems. Automotive sensors must satisfy a difficult balance between accuracy, robustness, manufacturability, interchangeability, and low cost. Although, automotive sensors have three major areas of application, namely; powertrain, chassis and body. Fleming
(2008) further categorized sensors into the following:-

a) Speed/Timing Sensors; are used to measure engine crankshaft/camshaft speeds and angles for control of spark timing and fuel injection timing. The sensors are also used for control of transmission input and output shaft speeds for electronically controlled gear shifting. In addition, high-resolution crankshaft speed sensors detect

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engine misfire, as evidenced by cylinder misfire-induced modulations of crankshaft speed. Another major application is wheel speed measurement of each vehicle wheel to provide inputs to antilock brake, traction control, and vehicle stability systems. Wheel speed sensors are mounted in wheel hub housings, and operate in a severe environment that includes roadway curb impacts and pot-hole-induced shocks.
(Fleming's New Sensors Review 2008)

b) Position sensors; are the type of sensors used to measure engine throttle plate angle, accelerator pedal position, fuel level in the tank (float arm angle), steeringwheel angle and chassis-height link-bar angle. However, there are different construction of position sensors such as: Potentiometric, Hall-effect, effect, anisotropic magneto-resistive (AMR), giant magneto-resistive (GMR) types of position sensors. A new dual-magnet type of steering-wheel angle sensor has been developed for automotive applications for the steering-wheel angle sensor include: vehicle electronic stability control, steerable headlights, parking assist, and road navigation. (Fleming's New Sensors Review 2008.

c) Pressure Sensors; the automotive applications of pressure sensors include: engine manifold absolute pressure, ambient barometric pressure, and evaporative fuel system leak pressure. And also applicable in brake fluid pressure. Other types of pressure sensors include; Integrated Multi-parameter Tire Pressure Sensor: The standard requires that TPMS sensors, within 20 min, detect a 25% pressure-deflation in any or all vehicle tires. This includes the situation where all four tires deflate uniformly due to seasonal falling temperatures.

d) Temperature Sensors; the operating temperature ranges for these sensors are as follows: For temperature applications in the range of 50°C to 150°C, silicon IC sensors are used. Thermistor-type sensors operate in various ranges as high as 1000°C.To measure very high temperatures over 1000°C, Resistive temperature detectors (RTDs) sensors are commonly used. Automotive applications of temperature sensors include: Measurement of air and fluids using silicon IC sensors. Engine coolant, fuel, brake, and steering fluid levels are commonly measured using thermistors. (Fleming's New Sensors Review 2008)

e) Mass Air Flow Sensors: Mass air flow sensors measure steady state and transient mass flow of air into an engine. An engine's combustion process is controlled by mixing the correct ratio of fuel to the mass, *not volume*, flow of intake air. Accurate mass air flow measurement permits precise metering of fuel into an engine for control of vehicle emissions, economy, performance and drive-ability. There are three methods of measuring automotive mass air flow.

Electronic Control Unit

Electronic Control Unit (ECU) is often referred to by many other names, such as electronic control module, brain box or simply the computer. However, the most commonly used name is the electronic control unit, which is generally abbreviated to ECU. Although the ECU can provide a number of functions and perform a number of tasks, it is primarily **the brain** of the system because it effectively makes decisions.

In reality, an ECU makes decisions based on information received (from sensors) and then performs a predetermined task (which has been programmed into the ECU). Whereas a human brain is capable of free-thinking, an ECU is very much restricted in its decision making process because it can only make decisions that it has been programmed to make. (Hillier, Coombes and Rogers 2006).

In reality, ECUs and computers in general are progressively becoming more sophisticated, and their programming is becoming increasingly complex. ECUs can adapt to changing conditions and can 'learn', which allows alternative decisions to be made if the original decision does not have the desired effect. A human can make a decision based on knowledge or information; if the first decision does not then produce the desired result, an alternative decision can be made because the human brain possesses the ability of free thinking. Modern ECUs do have a similar capability but it is a programmed one, designed by humans. The decision making capability of an ECU is therefore dependent on the volume and accuracy of information it receives from sensors and the level of sophistication of the programming to command Actuators.

Automotive Actuators

Actuators are there to complete the entire task of the ECU. If we re-examine the purpose of ECU controlled systems, the objective is to control a function or task using the speed

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and accuracy that an ECU provides. Therefore, when the ECU has received the required information and made the appropriate calculations, the ECU will provide a control signal to a component, which will then perform a task. In general, those components that receive a control signal and then perform a function or task are referred to as **actuators**. Shehu, Inti, Salihu, Iliya. B & Adamu (2016). The term **actuation** is generally assumed to mean that something is moved or actuated, and, in a high percentage of cases with ECU controlled systems, this is true. The ECU control signal that is passed to the actuator causes some form of movement of a component, such as opening an air valve or moving a lever.

Actuators that could be fitted to an engine management system, include; fuel injector solenoid (for fuel quantity control), Idle speed stepper motor (for idle speed control), Exhaust gas recirculation solenoid valve (part of an emission control system),

Turbocharger waste-gate solenoid valve (controlling turbocharger boost pressure). Ignition coil (in this instance, the ECU is in fact controlling the ignition timing when it switches the ignition coil on/off, although strictly speaking the ignition coil is not an actuator, (Hillier. Coombes and Rogers 2006)) and variable valve timing control, all are the example of actuators currently used in modern vehicles.

Methodology

Explanatory sequential mixed method design was used for the study. The design also called a two-phase model; (Creswell 2012). The design found suitable to answer the research questions in this study because, it allows the researcher to collect both the quantitative and qualitative form of data. A descriptive survey method was used for the quantitative data collection which allows the researcher to collect data from a fraction of the population, rather from every member of the population (Ziblima, Jacob & Issifu 2018). While on the other phase, in-depth exploration method through open ended interviews, was used for the qualitative data collection.

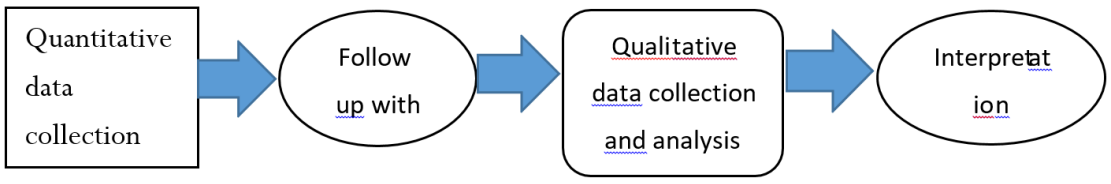

Fig. 1 Explanatory sequential mixed method designs

The population for the study, was registered Automobile Service Technicians with Nigeria Automobile Technicians Association (NATA) in Bauchi state. Therefore, total population of 1,886, from the three zones of the state. Purposive sampling was used and drawn out sample of 188 Service Technicians from the three zones as shown in a table below.

Table 1. Sample Distribution of the population of Service Technicians.

S/N	Zones	Service Technicians **1** Bauchi South (Zone A) 153
2	Bauchi Central (Zone B)	10
3	Bauchi North (Zone C)	25

The purposive is necessary because the study investigating the diagnostic skills needed and not every technician possess the skills and knowledge. Therefore, an individuals with the rich information and willing to participate were only selected in the study. And also some specific workshops were selected within the metropolis for the second phase of the study. Because in purposive sampling, the researcher intentionally select individuals and sites to learn or understand the central phenomenon. (Creswell 2012).

The researcher administered ADSN questionnaire which was validated by three experts and the internal consistency was determined using Cronbach Alpha and coefficient of 0.78 was obtained. The retrieved copies were scored and generate the data to use for the phase 1 of study. On the other hand, the phase 2 of the study. Semistructured interviews developed from the research questions were used for the data collections. In addition, an audio recording device was used in the entire process for better analysis. Data collected from the retrieved questionnaires (phase 1) was analysed using mean and standard deviation with the help of Statistical Package for Social Science (SPSS) software, version 23. The mean and the standard deviation were used in answering research questions. The response modes was assigned numerical values as follows: Highly Needed - 4 points, Needed - 3 points, Moderately Needed - 2 points, Not Needed - 1 point. For scoring the research questions. The decision for each research question was based on the resulting mean scores interpreted relative to the concept of the real lower and upper

limit of numbers shown in Table 2. However, the analysis of the qualitative phase of the study was started by transcribing audio-recorded interviews manually. The transcribed data were used as the basis for the analysis through thematic method of data analysis. The researcher adopted the thematic analytical procedure proposed by Creswell (2012).

Table 2: Decision Rule

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

RESULT AND DISCUSSION

Research Question 1: What are the skills needed by automobile service technicians in detecting faults for the maintenance of modern vehicles in Bauchi state?

Table 3. Mean responses of service technicians on automotive diagnostic skills on detecting of faults for the maintenance of modern vehicle.

S/N	ITEMS	M	SD	RMK
1	Ability to confirm the presence of the fault(s)	3.98	0.15	HN
2	Ability to generate vital information from the vehicle driver	3.82	0.44	HN
3	Check for previous work done records of the vehicle	3.52	0.70	HN
4	Ability to check for obvious problem within the suspected component or systems	3.75	0.54	HN
5	Ability to understand the operation of malfunction indicator light (check light)	3.81	0.52	HN
6	Ability to understand the weather of both environment and vehicle engine	3.63	0.63	HN

7	Familiar with all the signs and symbols on the vehicle dashboard	3.87	0.40	HN
8	Performing drive test to verify the presence of the fault(s)	3.55	0.72	HN
9	Physically differentiate the types of lubricant/fluid and their conditions	3.76	0.59	HN
10	Ability to observe the sound and the condition of the vehicle	3.80	0.54	HN
	Grand Mean	**3.75**	**0.52**	**HN**

Field survey (2023) KEY; ***M=mean, SD= Standard Deviation, RMK= Remark***

The data in Table 3 above, revealed item 1 and 7 having the highest mean of 3.98 and 3.87 respectively while item 3 and 8 have the least mean of 3.52 and 3.55 respectively. The grand mean of 3.75 with 0.52 standard deviation was obtained. This implies that all the diagnostic skills in detecting of fault are accepted as highly needed in maintenance of modern vehicles.

Research Question 2: What are the skills needed by automobile service technicians on the use of tools and equipment for the maintenance of modern vehicles in Bauchi state?

Table 4. Mean responses of service technicians on automotive diagnostic skills on the use of tools and equipment for the maintenance of modern vehicle.

S/N	ITEMS	M	SD	RMK
11	Observe safety rules and regulations in use of diagnostic tools and equipment	3.88	0.34	**HN**
12	Exhibit self confidence in handling diagnostic tools	3.80	0.45	**HN**
13	Ability to use diagnostic tools in narrowing the fault to a specific component or system	3.82	0.44	**HN**
14	Locate the position of data link connector (DLC) port		3.77	0.55
	HN in modern automotive vehicles			

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15	Retrieve diagnostic trouble codes DTCs using scan tools	3.80	0.46	**HN**
16	Proper interpretation of the DTCs been retrieved	3.85	0.41	**HN**
17	Test compression and pressure output with appropriate gauges	3.68	0.50	**HN**
18	Check function by reading the live data of all type of sensors	3.74	0.54	**HN**
19	Ability to make decision on a moment observed during diagnostic process using tools	3.67	0.53	**HN**
20	Ability to be effective and lifetime learner of technology	3.67	0.60	**HN**
Grand Mean		**3.77**	**0.48**	HN

Field survey (2023) KEY; ***M=mean, SD= Standard Deviation, RMK= Remark***

The data in Table 4 above, shows item 11 and 16 having the highest mean of 3.88 and 3.85 respectively, while item 19 and 20 have the least mean of 3.67 and 3.67 respectively. The grand mean of 3.77 with 0.48 standard deviation was obtained. This also implies that all the diagnostic skills in the use of tools and equipment are accepted as highly needed in the maintenance of modern vehicles.

Table: **5.** list of categories and themes generated from interview conducted with experts on automotive diagnostic and maintenance of modern vehicles in Bauchi State.

☐	First category:- skills needed in fault detection	
	Theme 1	Western knowledge
	Theme 2	Fault presence and descriptions
	Theme 3	Wire colour code and ignition mode
	Theme 4	OBD, EC system and DTCs interpretations
	Theme 5	Retraining for capacity building

☐	**Second category:- skills needed in handling modern automotive tools**	
	Theme 1	Understanding system diagnosis and tool selection
	Theme 2	OBD II scanner knowledge for modern diagnosis
	Theme 3	The importance and power of OBD II scanner
	Theme 4	Other diagnostic tools

Skills Needed in Detecting Fault in Modern Vehicle

The skills needed in detecting fault in modern vehicles emerged from the result of phase II are as follows;

i. Western Education: western knowledge serves as a bedrock of almost every aspect of modern vehicle maintenance. The education needed here is for the Technician to be able to read, write and communicate fluently and most importantly mechatronic knowledge. That will enable him carry out the diagnosis process proficiently.

ii. Knowledge of automotive fault, its descriptions that is signs and symptoms that enable the Technician to differentiate the diverse automotive troubles and their courses to confirm the present of fault before the occurrence of failure.

iii. Knowledge on the wire colour codes and ignition mode of a particular vehicle been under maintenance. The knowledge and skills would enable the Technician carry out diagnosis process effectively and prevent him from further the trouble or damage some component or the entire system.

iv. Knowledge on the electronic Engine Control Module (ECM) system, On-Board Diagnostic (OBD) system and Diagnostic Trouble Codes (DTCs) its meanings and interpretations.

v. The Technician were advised to stay up-to-date to the current technology revolution in the automotive industries through research, learning new things, retraining and etcetera, for capacity building.

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Skills Needed in Handling Tools and Equipment for Maintenance of Modern Vehicles Handling automotive tools and equipment means knowledge of tools/equipment, classification, types and how to carryout diagnosis process with it and their maintenance. The following needs emerged from the result;

i. The Technician were needed to have Knowledge on the tools, how to use and maintain it. And also understanding system diagnosis by possessing knowledge on what to be use on what to diagnose.
ii. OBD scanner, the technician should have the ability to select type of OBD to diagnose and must have the operational skills of the OBD scanner.
iii. The position of OBD Scanner among other tools made it compulsory for the technician to lean and possess the operational skills of the OBD Scanner, for diagnosing and maintenance of modern vehicle.
iv. There are also another important tools must learn how to operate by the Technician in the aspect of diagnosing and maintenance of modern vehicle. Such as Digital multi-meter, testing bulb, engine compression tester and fuel pressure tester.
v. The technician also required to be knowledgeable on electronic engine control tools recommended by manufacturers.

Integration and Discussion of Findings

This section presents the integration of both quantitative and qualitative results through narrative; weaving approach. Weaving approach involves writing both quantitative and qualitative findings together on a theme-by-theme or concept-byconcept basis (Creswell 2012). Therefore, the themes here are generated from the research questions of the study

Theme 1: Skills Needed by Automobile Service Technicians in Detecting Faults The study identified critical skills necessary for technicians to effectively detect faults in modern vehicles. Key findings from Phase 1 indicated that the highest-rated skills included the ability to confirm the presence of a fault (mean = 3.98) and familiarity

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with dashboard symbols (mean = 3.87). Conversely, checking previous work records and performing drive-tests received lower ratings (means of 3.52 and 3.55). Overall, the grand mean was 3.75, indicating a strong consensus on the importance of these skills. Phase 2 corroborated these findings, emphasizing the necessity of Western education for technicians, particularly in fault detection and mechatronic knowledge. Supporting literature highlighted the significance of confirming faults before diagnosis and understanding system operations as fundamental aspects of effective diagnostic processes.

Theme 2: Skills Needed by Automobile Service Technicians in Handling Diagnostic Tools

Phase 1 findings revealed that all skills related to handling diagnostic tools were deemed essential, with observing safety rules receiving the highest mean (3.88). This emphasizes the need for precautions to minimize accidents during maintenance. Phase 2 highlighted the importance of the OBD Scanner, stating that technicians must be adept at using it and selecting the appropriate type for diagnosing modern vehicles.

Additional highly-rated skills included proper interpretation of Diagnostic Trouble Codes (DTCs) and using various diagnostic tools to narrow down faults. The literature suggests that many technicians currently lack the skills necessary for effective use of digital diagnostic tools, leading to diminished patronage from modern vehicle owners.

Summary, Conclusion and Recommendations

This research focused on the automotive diagnostic skills needed by service technicians for maintaining modern vehicles in Bauchi State, Nigeria. Given the complexity of today's vehicles, which incorporate numerous mechanical, electrical, and computerized systems, technicians face significant challenges in diagnosing and repairing faults. The study aimed to identify essential skills in two areas: detecting faults and handling tools/equipment. An explanatory mixed-method research design was employed, involving a sample of 188 service technicians and three expert interviews to gather comprehensive data.

Findings revealed critical diagnostic skills necessary for modern vehicle maintenance. Technicians must possess knowledge of Western automotive standards, fault detection processes, and the interpretation of dashboard indicators. Understanding wiring codes, ECM, OBD systems, and DTCs is also crucial. Additionally, expertise in using diagnostic tools, particularly OBD II scanners, was identified as essential for accurate fault diagnosis and repair. The study emphasized that all 20 identified skills were deemed highly necessary and supported by expert corroboration and relevant literature.

The study concludes that modern automotive technicians must adapt to evolving technologies, necessitating continuous education and training. Recommendations include enhancing technicians' Western education to improve communication and comprehension and encouraging experienced technicians to mentor younger ones in the use of modern diagnostic tools. These steps aim to strengthen automotive maintenance capabilities in Bauchi State and ensure technicians remain competent in a rapidly advancing field.

REFERENCES

Abubakar S., Said I. A., Lawan F. G. & Sani M. G. (2021) "A Rule-Based Expert System for Automobile Fault Diagnosis" Published by *International Journal on Perceptive and Cognitive Computing* (IJPCC) Retrieved January 10th 2022 from file:///C:/Users/user/Downloads/1488.pdf

Adamu M.K (2015). "Capacity Building Needs Of Automobile Technology Lecturers in Federal Colleges of Education (Technical) In North-East, Nigeria

ConsuLab Presentation (2018 Version) Electrical Diagnostic strategies for today's vehicles. https://www.consulab.com/files/electricalDsHandoutv20181r1reduced.pdf

Creswell J. W. 4th edition (2012) Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative research. The book was set in Garamond by TexTech. It was printed and bound by Edwards Brothers, Inc. The cover was printed by Phoenix Color Corp.

Denton T. 4nd Edition (2016) Advanced automotive fault diagnosis. Published by Elsevier Ltd. Retrieved August 11 2021 from https://d1wqtxts1xzle7.cloudfront.net/48709947/advanced_automotive_fault_diagno

Ezeama A.O., Obe P.I. & Ede E.O.(October, 2016) "Assessment of capacity building needed among motor vehicle mechanic trainers for the use of auto scan tools" Published by *Nigerian Journals of Technology* (NIJOTECH) Vol. 35, pp. 805 – 813 Copyright©

Electronic ISSN: 2467-8821 www.nijotech.com http://dx.doi.org/10.4314/njt.v35i4.15

Fleming J. W. (2008). New Automotive Sensors—A Review Published by IEEE Sensors Journal, Vol. 8, No. 11, Retrieved October 11th 2021 from https://ieeexplore.ieee.org/document/4666729

Halderman D. J. (2012) Chapter 31 Engine Performance Diagnosis and Testing Book titled "Automotive Technology: Principles, Diagnosis, and Service" Canadian Edition (ISBN 0-13-124890-1) Retrieved October 22nd 2021 from https://studylib.net/flashcards/explorer

Hillier V.A.W. Coombes P. & Rogers D. 5th Edition Book 2 (2006) Hillier's Fundamentals of Motor Vehicle Technology "Powertrain Electronics" published by Nelson ThornesLtd

Holmes T. (2021) Article "What are the Different Types of Auto Diagnostics?" Retrieved September 27th 2021 from https://www.infobloom.com/what-are-the-different-typesof-auto-diagnostics.htm

Inti, M. M., Abdul Latib A. and Rufai A. (2014) "An Appraisal of Technical Skills Possessed by Technical College Auto-Mechanics Graduates in Nigeria" Published by Industrial Engineering Letters www.iiste.org ISSN 2224-6096 (Paper) ISSN 2225-0581 (online) Vol.4, No.8, 2014

Lanigan E. P., Kavulya S., Narasimha P., Fuhraman E. T., and Salman A. M.(2011), Diagnosis in Automotive System. A survey. https://www.pdl.cmu.edu/ftp/ProblemDiagnosis/CMU-PDL-11 110.pdf

Muh'd Faisal, A. I., Yigitcanla. T., Kamrazzaman Md., and Currie G. (2019), Understanding Autonomous Vehicles: A Systematic Literature Review on Capacity, Impact, Planning and Policy. Published by *Journal of Transport and Land Use*. Retrieved August 21st 2021 from http://www.reseachgate.net.publication/330718512 or https://jtlu.org

Motavalli, J. (2010, February 4). The Dozens of Computers That Make Modern Cars Go (and Stop). *The New York Times*. New York. Retrieved September 15th 2021 from http://www.nytimes.com/2010/02/05/techn The Dozens of Computers That Make Modern Cars Go (and Stop).ology/05electronics.html?_r=0

National-Policy-On-Education 6th Edition (NPF 2014) Retrieved January 13th 2022 from https://education.gov.ng/wpcontent/uploads/2020/06/NATIONAL-POLICY-ONEDUCAT

Opeyemi, O. O. and Benjamin O. U. (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" Published by *American Journal of Mechanical and Industrial Engineering*. Vol. 5, pp.71-77. doi: 10.11648/j.ajmie.20200506.11

Prosser, C. A., & Quigley, T. H. (1949) "Vocational Education in a Democracy" American Technical Society, Chicago, Illinois.

Roner, K. C., (2014) "Improving Automotive Troubleshooting Skills" All Graduate Plan B and other Reports. 402. www.digitalcommons.usu.edu/gradreports/402

Shehu, I. Y, Inti M.M. Salihu Y, Iliya. B & Adamu (2016) "Approaches to Training and Diagnosis on Modern Automobile (Mechatronic) Vehicles in Technical Institutions of Nigeria"

Ziblima B. Jacob N. and Issifu I. (2018)"Assessing the Skills of Roadside Mechanics in Diagnosing And Fixing Problems of Modern Electronic Managed Vehicles in Ghana (Tamale Metropolis)" Publishing *by American Scientific Research Journal for Engineering, Technology, and Sciences* (ASRJETS) ISSN (Print) 2313-4410, ISSN (Online) 2313-4402 © Global Society of Scientific Research and Researchers