ASSESSMENT OF CHALLENGES FACED BY AUTOMOBILE MECHANICS IN THE MAINTENANCE OF MECHATRONICS SYSTEM IN MODERN VEHICLES IN ABUJA METROPOLIS

BY

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NIGERIA

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A PROJECT SUBMITTED TO THEDEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B.Tech) ININDUSTRIAL AND TECHNOLOGY EDUCATION

JULY, 2021

DECLARATION

I hereby declare that this titled: "Assessment of Challenges Faced by Mechanics in the Maintenance of Automobile Mechatronics System in Modern Vehicles in Abuja Metropolis" is a collection of my original research work and it has not been presented for any other qualification anywhere. Information from other sources (published or unpublished) has been fully acknowledged.

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……..
SIGNATURE & DATE

CERTIFICATION

This project titled "Assessment of Challenges Faced by Mechanics in the Maintenance of Automobile Mechatronics System in Modern Vehicles in Abuja Metropolis" by: AJOGWU, Michael Ojonugba 2014/1/53063TI meets the regulations governing the award of B.Tech degree in Industrial and Technology Education of the Federal University of Technology, Minna and it is approved for the contribution to scientific knowledge and literary presentation.

Mr. F. Abutu ……..
SUPERVISOR Signature & Date

Dr. I. Y. Umar ……..
HEAD OF DEPARTMENT Signature & Date

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EXTERNAL EXAMINER Signature & Date

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ABSTRACT

The study is to assess the challenges faced by automobile mechanics in the maintenance of mechatronics system in modern vehicles in Abuja Metropolis. The specific objective of the study is to determine skill requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles, determine maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles and to determine the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles. Three (3) corresponding research questions and null hypotheses were raised. The research design is a descriptive survey, the population of the study comprises of fifty (15) car users and twenty (20) automobile mechanic. The study concluded that most users of automobile, maintenance only comes to mind when their automobile fail; while others see maintenance solely as when repair is required. As a result of this, many vehicles end up broken down on the high way or abandoned in the auto-workshops all around the cities. This explicitly supports the fact that Nigerians, most registered engineers inclusive, lack maintenance culture. For the auto-mechanics, it requires serious re-engineering and training to bring them to align with modern trends in automobile maintenance. The study recommended that the automobile mechanic should possess the required skills to fix problems on vehicle suspension systems accurately, the automobile mechanic should possess the required skills to diagnosis modern vehicle, and the car user should possess a good, and periodic maintenance culture.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The automobile sector is considered one of the most important for a country's economy and trade because it shapes the industry, the cities, communal and individual life (Okuta and Dawha, 2014). According to Lopez and others (2015) digitization will drive more innovation in the automobile industry in the next 20 years than there has been in the past 100 years. The digital transformation of the automobile industry is, in effect, the innovative reassembly of customer and company resources, and of products and services, in order to grow value, revenue and efficiency via digital technologies. A similar story could be told with respect to the spread of digital technology for monitoring every aspect of engine performance. The pace of technological improvements, influenced by regulatory pressure, continues to grow. Technology to reduce the environmental footprint of motor vehicles will be even more vital in the future (Michael, 2015).

In Nigeria, modern cars are on the increase which ranges from various model and type plying most roads in the country on a daily basis. Most of the users of these cars dedicate little or no attention to constant maintenance of their cars except there are issues which might be caused by a fault developed on the cars. Some of these faults probably might be averted if constant measure of maintenance were put in place. The design of most modern cars requires adequate maintenance as described by the manufacturers of the cars, but it is quite unfortunate that buyers of the so called manufactured cars feel less concern about it after purchase. (Lee and Chung, 2013), posited that automobiles are consumer goods; the more they are used, the more

maintenance is required, and the costs of usage continue to increase. This implies that consumers should take maintenance service into consideration when purchasing new cars. Also, Dhal and Solanki (2017) view on maintenance, suggested periodic maintenance by car owners and advised them to take their cars for regular service and maintenance either after certain specified time period or distance covered. In vehicles the increase of comfort, safety, and reliability is the main goal together with the improvement in driving performance, fuel consumption, emissions, but also production processes. Mechatronics is not the only use of electronics and mechanics side by side, it consists of synergetic use of several engineering disciplines implementing electronics, actuators, sensors and communication system (Annum, 2015).

The term mechatronics was used in old Greece for the art of designing helpful machinery; in this sense, Mechatronics can be seen as modern way to design helpful machinery including electronic technologies. The synergic aspect means each of the different subtasks of the machinery should be realized in the most efficient way, be it electronically, manually or software. Wallaschek (2001). Growing number of high tech vehicles have features such as air-bags, global positioning systems, automatic climate controls with which automobilemechanics need to be familiar. Each of these systems require Electronic Control Unit (ECU) which reads sensor values from various parts of the engine and depending on these values it performs the appropriate actions. This allows the car to adapt to environmental conditions such as air density in order to increase the combustion efficiency and subsequently improving fuel economy (Edunyah, 2015).

Grove,Fowler Jr, and Couper(2011) stated that today, most automobile systems, such as engines, braking, transmission, and steering systems, are controlled primarily by computers and electronic components. Furthermore, an increasing number of high end vehicles have features such as air-

bags, global positioning systems, automatic climate controls with which automobile mechanics need to be familiar. Each of these systems require Electronic Control Unit (ECU) which reads sensor values from various parts of the engine and depending on these values it performs the appropriate actions. This allows the car to adapt to environmental conditions such as air density in order to increase the combustion efficiency and subsequently improving fuel economy (Edunyah, 2015). Continuing, Edunyah, further noted that majority of the new trend cars now come with electronic control unit (ECU) and other electronic gadgets which sense instant fault in the vehicle and immediately notifies the driver through the malfunction indication lamp (MIL) or dashboard display. In the opinion of Erjavec (2010), the automobile changed when the roads became paved, more people owned cars, manufacturers tried to sell more cars, concerns for safety and the environment grew, and new or emerging technologies were developed.

Maintenance had been defined as an activity applicable to all systems, natural and artificial, to cause such systems to remain unaltered or unimpaired. It is the repair activity carried out on vehicles or other machineries to keep them unaltered, and if altered, to restore them to their original state (Jalal, 2013). Maintenance is the adherence to the manufacturer's schedule for vehicle upkeep plus the repair of systems or faults that have led to excess emissions. The ability to effectively carry out maintenance in modern vehicles requires the use of new and diagnostic skills different from the conventional technical skills already acquired by automobile mechanics.

According to Kayemuddin, (2013), automobile also known as motor vehicle is a complex technical system in which various subsystems operate in harmony to discharge a defined function. In the view of McLeod (2014), automobile is a wheeled vehicle that carries its own motors and has seats for both the driver and passengers. Assorted brands and models of

automobiles therefore abound today on the Nigerian roads and are used for either public or convenience and luxury of personal transportation. Santini (2014) reported that Nigeria spends a whopping N400 billion naira annually to import different kinds of automobiles into the country while the country presently has 13 million vehicles plying its roads.

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. These call for a skillful mechanic to be able to deal with modern day vehicle design. The skills of auto mechanic are often developed contemporaneously in workshop. Practical skills referring to the ability to use tools effectively and in an efficient manner, the ability to undertake the work of the day such as brake repair, transmission rebuilding and the like, and the ability to diagnose problems associated with repair of automotive vehicles (AkinyemiandKoyejo, 2011).

According to Ambe (2014), roadside mechanics acquire skills but 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. Agebure (2014) indicated that productivity was low in automotive workshops in Africa as the service was rendered by hands,tools and equipment used were mostly outdated and these affected their ability to work on complex systems especially electronic and automatic transmission systems. Therefore the study needs to assess the challenges faced by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis

1.2 Statement of the Problem

Automobile maintenance method, over the years, has changed greatly. This is as a result of complete evolution of mechatronics in modern automobiles, modern automobiles are complex and sophisticated- involving the use of electronic control unit. The Modern Automobile is thus a highly sophisticated machine incorporating numerous efficient and dependable mechanical, electrical, electronic and computerised components and systems.Santini (2014). However, mechanics lack the skills to work not only with special tools and diagnostic equipment, but also with sophisticated electronics and computer systems.

Automobile mechanics play important role in the socio-economic development of Nigeria. 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 automobile mechanic to properly diagnose and fix problems associated with vehicles. 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.This raises the need for competent automobile mechanics to meet the challenges that come along with these innovations in the automobile industry most especially the automobile maintenance sector of the industry. Users of modern automobiles will expect value services for what they own and pay for at the point of maintenance with a sense of confidence when there is need to visit the maintenance technician.Okuta, and Dawha (2014).

1.3 Purpose of the Study

The purpose of the study is to assess the challenges faced by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis. The study is to determine:

1. Skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles.
2. Maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles.
3. Skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles.

1.4 Significance of the Study

The findings of this study were of immense benefit to automobile mechanics, Automobile Industries, Government and the society at large. The acquisition of modern diagnostic skills identified in this study will enable automobile mechanics to become self-reliant, self-employed and employers of labour. The findings will also enable automobile graduates to acquire new competencies for servicing and repair of modern mechatronic systems in modern vehicles in order to remain relevant in the automobile industry. The automobile maintenances skills identified in this study when integrated, could help automobile mechanics and car owners to acquire new set of skills required for servicing and maintenance of modern vehicles. Mechanics 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 findings of this research will also benefit car users, as automobile mechanics acquire the right maintenance skills, they were gainfully employed, thus contributing to the improvement of the society and the country as a whole.

The findings of this research were useful to the automobile mechanics by given the mechanics insight and better understanding of the skills that are expected of them for self-employment and employment in the industries. Artisans (road side mechanics) who are products of the informal automobile sector will benefit from the findings of this study by becoming more enlightened on the modern automobile and strive towards updating their knowledge and skills in line with the identified maintenance skills. This will enable them to keep pace with technological improvements for performing optimally and remain relevant in the modern automobile industry.

Automobile servicing companies will equally find the result of this study very beneficial when incorporated into after sales services of modern automobile in their service centers as it will produce a pool of highly skilled automobile mechanics (craftsmen) who were 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 agencies on the performance gap between technical skills acquired by automobile mechanics and the requirements of modern automobile industries. Hence, the government were encouraged to organize retraining programmes and skill improvement workshops of automobile artisans whose responsibility it is to make use of this maintenance skills for gainful employment.

The findings of this study will also sensitize the society, who are the users of these modern cars in changing their mindset regarding constant maintenance of their cars. The findings of this study will enlighten them that, the design of most modern cars requires adequate maintenance as described by the manufacturers of the cars.

1.5 Scope of the Study

The study is limited to the assessment of the challenges automobile mechanics faced in the maintenance of automobile mechatronics system in modern vehicle. With respect to skills required by Automobile mechanics in the maintenance of Automobile mechatronics system in modern vehicles and also the approach to be adopted by car users in the maintenance of Automobile mechatronics system in modern vehicles.

1.6 Research Questions

The following research Questions were raised to guide the study

1. What are the skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles?
2. What are the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles?
3. What are the skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles?

1.7 Hypotheses

The following null hypotheses were formulated at level of 0.05 significance

H_{01}: There is no significant difference in the mean rating of automobile mechanic and car users on the skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis.

H_{02}: There is no significant difference in the mean rating of automobile mechanic and car users on the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles in Abuja metropolis.

H_{03}: There is no significant difference in the mean rating of automobile mechanic and car users on the skill required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles in Abuja metropolis.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

In a research report carried out for city and guilds centre for skills development by Faraday, Overton and Cooper, (2011) on the importance of skill update and effective teaching in vocational education, it was established that: skills development is a key factor in the employability of workers and the sustainability of enterprises. It is one of the objectives of skills development systems to ensure that the skills acquired match the skills valued in the workplace; skills development systems must also help workers and enterprises adjust to change and handle new conditions by constantly improving their skills to meet up with climatic change, globalization, demographic trends, technological innovation and/or financial crisis. This was built on the theory of technical and vocational skill development(TTVSD) by Stevenson (2003) based on Buford Stefflre's ten propositions in search of a theory of vocational development. TTVSD states that "Improvement needs in skills development underlie vocational choice, development, employability, mobility and sustainability of socio-economy of every progressive society". This theory is relevant to this study because technological innovations in the modern automobile are complex and each sub-system of the modern automobile is indeed a challenge to the automobile maintenance industry in Nigeria.

Theories are postulates requiring further explanations in order to make meaning. According to Jamabo&Kinanee (2004), theories can be described as a set of concepts, principles, propositions and generalizations that are logically interconnected which present a systematic view of phenomena that enable the user to describe, explain, predict or advance knowledge. Theories are

thus the foundation of any research (Olaitan, Ali, Eyo&Sowande, 2000). In other words, theories are principles on which a subject of study is based. When a theory is applied in teaching and learning, it provides the principles, which directly governs it (Nwachukwu, 2001). Continuing, Nwachukwu stated that for a theory to be useful, it should play two important roles such as:

i. It should serve as a process of systematizing information in an area of knowledge thereby leading to the discovery of unknown facts; and
ii. It should summarize information in such a manner that is easily used to explain a given concept.

Therefore, the theoretical foundations upon which this study is based are Dreyfus model of skill acquisition, Dynamic skill theory and Psychological theories of the Refugee and Schumpter effects.

Dreyfus Model of Skill Acquisition

Stuart and Hubert Dreyfus (1980) propounded the "Dreyfus model of skill acquisition" which states that formal system of education is a gradual process that involves being embodied in different ways and developing skills that would make it possible for people to deal with the world. The main idea behind the Dreyfus's model of skill acquisition is the distinction they make between "knowing that" and "knowing how". The two concepts are considered as one concept, which is acquired through a formal system of education. According to Stuart and Hubert Dreyfus (1980), learners acquire skills through instruction and experiences; they do not appear to leap suddenly from rule-guided "knowing that" to experienced based knowing-how. The Dreyfus model of skill acquisition is a model of how students acquire skills through formal instruction and practicing. They believe that there is a gradual process involved for a learner to go through in

order to reach the stage of expertise or knowing-how. The original model proposes that a student passes through five distinct stages: novice, competence, proficiency, expertise, and mastery. However, these stages of skill acquisition relates to this study in the following ways:

i. Novice Stage: At this first stage, a person follows rules as given, without context, with no sense of responsibility beyond following the rules exactly. In the process of learning the rules, students upon graduation are already exposed to the basic knowledge and principles of skill acquisition in order to prepare him for emerging technology skills for the maintenance of modern vehicles.

ii. Advanced Beginner: The learner at this stage recognizes new situations in which the rules may be applied. Student's performance improves to a relatively acceptable level only after the novice has had enough experience in copying the real situation, the students starts to show unique performance through personal experience.

iii. Competency Stage: Competence develops when the individual develops organizing principles to quickly access the particular rules that are relevant to the specific task at hand; hence, competence is characterized by active decision making in choosing a course of action. Student's at this stage begins to get involved personally with the task. They start seeing more than one option from which they have to choose the best one for optimal performance.

iv. Proficiency Stage: Proficiency is shown by individuals who develop intuition to guide their decisions and devise their own rules to formulate plans. The progression is thus from rigid adherence to rules to an intuitive mode of reasoning based on tacit knowledge. This is the stage where the student while intuitively understanding his task, still thinks

analytically about his actions. The student must have acquired basic skills that will enable him think creatively towards becoming self-employed after graduation. Hence, analysing ways of raising capital, location of business and other business strategies becomes his priority.

v. Mastery Stage: Experts in general know what to do base on mature understanding of the task. An expert has had so much experience with the task that the skill of carrying out the task is part of him. He acts upon correct intuitions without analytically thinking about his every move. They also emphasize on the fact that practice is required for the agent to maintain the knowing-how. Without practice, the agent will gradually lose his expertise and most likely to regress as far as the competence stage.

Dynamic Skill Theory

Kurt Fisher (1980) propounded the theory "the dynamic skill theory", which states that skill within domains may promote or suppress other skills as they first develop resulting in spurts of growth in one skill concurrently with regression in another. The dynamic skill theory is related to the present study in that when it is applied to skills in automobile emerging technology. As such, it will enhance skill development and improvement in the utilization of new technologies (diagnostic/scan tools and equipment).

Psychological Theories of the Refugee and Schumpter Effects

There remains considerable theoretical debate regarding the causes, consequences and solutions for unemployment. Unemployment (or joblessness), as defined by the International Labour Organization, occurs when people are without jobs and they have actively sought work within the past four weeks. It is on this basis that Schumpter (1954) propounded the psychological theories

of the Refugee and Schumpter effects which state that the ability to make a good judgement about the future leads an individual to become a successful entrepreneur.

Schumpter further suggested that financial stimuli, public job creation and expansionist monetary policies are what will enable entrepreneurship to create jobs and help quell unemployment crisis in any economy.

The Refugee Effect

This process of unemployment fast-tracking entrepreneurship activity has been termed a "refugee effect". This remarkable view dates back at least to Oxenfeldt (1943), who pointed out that individuals confronted with unemployment and low prospects for wage employment often turn to self-employment as a viable alternative. This observation was also an extension of Knight's view that individuals make a decision among three states – unemployment, self-employment and employment. The simple theory of income choice lends credence to refugee effect by suggesting that increased unemployment will lead to an increase in start-up business activity on the grounds that the opportunity cost of not starting a firm has decreased (Evans and Leighton, 1990; and Blanchflower and Meyer, 1994). Similarly, Picot et al. (1998) and Pfeiffer and Reize (2000) observe that new firms hire the needed employees to work for them, thus helping to reduce the level of unemployment in the society. Evans and Leighton (1990) found that unemployment is positively associated with greater propensity to start a new firm.

The Schumpter Effect

The process of entrepreneurship activity reducing unemployment situation in the economy is termed "Schumpter effect". The main idea behind the Schumpter effect is that unemployment is negatively related to the establishment of new firms. This implies that as new businesses are

established, employability is stimulated and unemployment reduces substantially (Garofoli, 2004; Audretsch& Fritsch, 1994). In the same vein, Lucas (1978) and Jovanovic (1982) asserted that high unemployment in the society is associated with a low degree of entrepreneurial activities, that is, where propensity to set up enterprises is low; the rate of unemployment would be very high. The implication of the above assertions is that those who are unemployed tend to remain so because they possess lower endowments of human capital and entrepreneurial talents required to start and sustain new enterprises to keep them going. A low rate of entrepreneurship culture and skills in any society may be a consequence of the low economic growth, which also reflects higher levels of unemployment (Audretsch, 1995, Oladele, P. O. et al, 2011).

However, the Schumpter effect is in line with the present study in the sense Motor Vehicle Mechanic's Work graduates who possess positive entrepreneurial capabilities and technology skills in modern motor vehicle maintenance are likely to attain high levels of utility in self-employment and a successful entrepreneurship.

2.2 Conceptual Framework

2.2.1 Evolution of modern vehicles

The transmission of power by mechanical and electrical devices has long been in use in automobile industry. Today, with the advancement in engineering and technology, electronic devices are now taking the place of mechanical and electrical devices or electro-mechanical devices. A lot of vehicles are parked-up at homes, and a visit to a place like the "mechanic village", where automobiles are serviced or repaired, will reveal the rate at which automobile users, individuals or companies, visit their auto-mechanic for maintenance (Akele, Okoh, Ejiofor &Alimasunya, 2011).

The first fuel electronic system was introduced by Bendix in the USA in 1950. Seventeen years later a similar unit was made by Bosch and was fitted to a Volkswagen model. Today, it is necessary to fit electronic petrol injection systems to comply with emission regulations. The major differences, according to Hillier (2004), in the existing electronic injection systems today are in the method of metering or measuring the amount of air entering the cylinder, as this determines the amount of fuel required for combustion. These variants are;

i. Indirect – pressure /vacuum sensing systems (PSS)

ii. Direct – Airflow or air-mass sensing systems (ASS)

PS system uses a manifold absolute pressure (MAP) sensor to measure the manifold depression. Signals from the MAP sensor are passed to the ECU and, after taking into account the information received from the other sensors, the ECU provides a control signal for the injector to open for a set period of time proportional to the mass of air that the engine is receiving (e.g. the Bosch D-Jetronic System).

The AS system petrol injection system measures the volume or mass of air flowing into the engine by either an air-flow meter (vane or flap type) or an air mass meter (hot wire type). Both of these sensors produce an output signal voltage, which changes as the volume of airflow increases. The signal voltage is then passed to the ECU where it is used, in conjunction with other sensor information, to determine the period of time that the injectors should remain open. In all, to allow for optimal combustion taking place, the ignition spark with sufficient energy has to occur at precisely the right time in the engine cycle to ignite the correct amount of air-fuel mixture.

Developments in vehicle technology have produced an electronic ignition system that can increase the electrical energy over the conventional contact ignition system, as well as providing low maintenance ignition system. The electronic ignition system was succeeded by a 'maintenance-free' computer-controlled ignition system, which provided a system that continually adjusts the ignition timing to suit the engine conditions. At the end of the 1980s, the requirement for cleaner emissions meant that the carburetor fuel system needed to be replaced by an electronically controlled fuel system. (Hillier &Coombes, 2004). The term 'petrol injection' is used to describe any system in which pressurized fuel is injected out of a nozzle in an atomized state to mix with a supply of air.

Modern systems are controlled electronically because this form of control enables the fuel quantity to be accurately set to suit the engine operating conditions. Strict emission control regulations have demanded precise metering of the fuel, and although petrol injection systems are more expensive than carburetor fuel systems, they are now used to control the fueling on all engines. Most of these petrol injection systems are integrated with the ignition system into what is known as "engine management system".

A petrol injection system that delivers the correct quantity of highly atomized fuel gives the following, in comparison to carburetor engine:

1. Lower exhaust pollution
2. Lower fuel consumption
3. Higher power output
4. Smoother engine operation due to even power output from each cylinder.

These electronic devices, simple or complex, are used to better serve Man by improving on his environment (pollution control) and drivability. Emission regulations or control, worldwide, is becoming increasingly strict such that the automobile industry has had to continually research and develop designs of components (especially the inlet and exhaust systems) that will give optimal combustion of air-fuel mixture. This advanced engine management system technology is to aid in monitoring and controlling other engine components as well as those that have a direct effect on emission levels. Side by side this emission regulation requirement is the users' expectation for higher engine performance at preferably lower fuel consumption which works in direct opposition in trying to reduce emission from vehicle. It is a well-known fact that emissions from vehicles damage human health, plant life and the environment. (Donkundwar, 2007) This problem is particularly severe in areas where the geographic and climatic conditions create an atmospheric envelope which traps the pollutants.

2.2.2 Concept of maintenance in motor vehicle

Maintenance is the act of ensuring that physical assets (machines, automobiles, plants etc) continue to do what they are expected (or designed) to do in their present operating context. (Moulbray, 1991). In other words, it is an activity that is applied to natural and artificial systems to cause the system to remain unaltered or unimpaired in its ability to perform its function(s). (Okah-Avae, 1995). Therefore, automobile maintenance has to do with the day-to-day up-keeping of an automobile in order to avoid or remedy failure problems.

However, to most users of automobile, maintenance only comes to mind when their automobile fail; while others see maintenance solely as when repair is required. As a result of this, many vehicles end up broken down on the high way or abandoned in the auto-workshops all around the

cities. This explicitly supports the fact that Nigerians, most registered engineers inclusive, lack maintenance culture. For the auto-mechanics, it requires serious re-engineering and training to bring them to align with modern trends in automobile maintenance. For an automobile, it requires a simple periodic or routine preventive maintenance practice as specified by the manufacturer to keep the automobile up and running.

Auto-maintenance Requirements

Automobile maintenance method, over the years, has changed greatly. This is as a result of the fact that,

1. Varieties of automobiles are available
2. Modern automobiles are a bit complex and sophisticated- involving the use of electronic control unit (ECU)

As a result of these, present day auto-maintenance personnel are faced with the challenges of how to overcome these aforementioned facts. According to Moulbray (1991), some key challenges that maintenance personnel encounter in an attempt to solve maintenance problems are:

1. Ability to select the best maintenance techniques.
2. How to deal with each type of failure processes encountered.
3. How to fulfill the expectations of the customers of the automobiles and,
4. How to carry out auto-maintenance in the most cost effective enduring manner.

The automobile industry is one of the largest industries in Nigeria; under the umbrella of which is one of the largest informal sector (auto dealers, auto-mechanic, auto-electrician, auto-body works mechanics or panel beaters, and vulcanizers) that is a major job provider within Nigeria (Akele, 2011). Auto-mechanics are usually products of apprenticeship training programmes with little or

no formal education and mainly sponsored by parent or guardians (Ogwo, 2004). Therefore, for the conventional automobile mechanics to be able to carry out proper and complete maintenance or repairs, he has to be properly re-educated in the working principles of modern vehicle systems. This of course, will re-engineered him to be a better auto-mechanic with high quality of workmanship.

According to King (2000), diagnosing problem on modern vehicles fitted with complicated electronic systems takes a little different approach than many automotive mechanics are used to. Service manual is expected to be consulted with the procedures there-in carefully followed. It is very useful to spend some time familiarizing oneself with the diagnostic guides and charts that manufacturers present in the service manual. So, any mechanic who has previously acquired formal education will have little or no problem dealing with modern ECU vehicles as this ability will make it easy for him to be able to read service manual and use the computerized equipment (e.g. scanners, monitors etc.) usually used to diagnose and solve problems. Therefore, education and training in ICT are important requirements needed by every automobile mechanic.

Necessity of Maintenance Management Programme

Every auto-garage has to be re-educated into having a good maintenance management programme in place. This should contain questions that will enable easy or systematic repairs to be carried out. Moulbray (1991) suggested that before maintenance task could be performed a maintenance technician should have ready answers to questions such as,

1. What are the functions and associated performance standards of the automobile at the fail state?
2. In what ways does the automobile fail to fulfill its function(s)?

3. What causes the functional failure?
4. In what ways does the failure matter or affect the automobile user?
5. What can be done to predict or prevent this failure from occurring in future?

This systematic approach to maintenance task if applied by the road-side mechanic, will have re-engineered our conventional auto-mechanic to abandon the costly and dangerous trial and error method they are used to. Any maintenance personnel who will consider providing answers to these questions before maintenance is carried out in a vehicle, would have carried out not less than 50% of the maintenance task as the answers will act as guide to carrying out the task.

Maintenance Management Programme Success

It is not enough to have a maintenance management programme but ensuring that every aspect of the programme is strictly adhered to and implemented. The success of any maintenance management programme depends on proper planning and scheduling of maintenance task, the mechanic's understanding of how the automobile systems and sub-systems work and how components are interrelated, proper documentation of data and information on maintenance procedures, plans, inventory, cost implications and safety sheets; availability of equipment and tools as well as spare-parts; education, seminar and workshop attendance to enable familiarization with trends in modern automobile technology.

Why Automobiles Fail

Failures do not just occur in automobiles. Certain factors are always attributed to why automobiles do fail. According to Akele (2009), deterioration due to friction and wear, thermal degradation, internal reaction and corrosion, design flaws and material selection during design stage, operating the automobile beyond its operating limits or severe conditions, and quality or

degree of technical-know-how of the automobile mechanic can be attributed to why automobiles do fail. Without fatigue, stress (mechanical or thermal), friction or wear in automobile systems or components maintenance will not be necessary and automobile will be expected to operate perpetually. The moment our automobile is put to use, deterioration will start to set in gradually such that with time, poor operation, efficiency, high vibration and noise, lubricant leaks and fuel spills will be observed. At this moment, visits to the maintenance workshop become more frequent due to frequent failures (Akele, 2009).

Engine Management System

According to Hillier and Coombes (2004), electronic petrol injection provides precise fuel delivery and therefore cleaner emissions that are accompanied by an increase in engine load and fuel economy. To monitor the engine's operating conditions, these electronically controlled ignition and fuel systems use very similar sensor information systems, although each system is completely independent. Therefore, the ignition ECU used a programme stored in its memory to control the ignition timing, and the fuel injection ECU used a programme stored in its memory to control the timing of the injection point and the quantity of fuel delivered. Although the ignition system adapts itself slightly with changes in engine performance (i.e. with the use of knock sensors), the fuel injection system maintains a fixed fuel delivery based on its own sensor information. Integrating these two control systems into one engine management system and therefore, one ECU allows the sharing of information provided by all of the sensors. Such integration also allows the ignition and fuel injection programmes to interact with each other and therefore provide the optimum control signals for both ignition and fuel throughout all engine operating conditions. The requirement for lower emissions has led to the fitment of the exhaust

catalyst, which reduces to function efficiently; the content of the exhaust gas entering the catalyst has to be precisely controlled. The engine management system has to therefore, control the ignition and fueling systems accurately, to control the content of the exhaust gases entering the catalyst. The system also provides accurate control of engine idle speed. The engine management system can also adapt itself to the changing conditions of the engine components, thereby providing a low level of emission throughout the vehicle's life. Integrated into the system is a self-diagnostic facility that constantly monitors the sensor and actuator signals. If a fault is detected, the system registers it and usually signals to the driver.

Electronically-controlled systems generally make use of various sensors and actuators. Sensors provide information to the computer electronic control unit (ECU). The computer then uses the information to calculate what actions to take by the actuator. In modern vehicle, a number of such as sensors are positioned around the engine to monitor operating conditions such engine temperature, load, speed, and detonation; around the gearbox, road wheels and so on. Signal information is passed from these sensors to the computer.

Types of maintenance:

Four general types of maintenance philosophies can be identified, namely;

i. Corrective maintenance
ii. Preventive maintenance
iii. Risk-based maintenance
iv. Condition base maintenance

Corrective maintenance: maintenance is carried out following detection of an anomaly and aimed at restoring normal operating conditions. This approach is based film belief that the costs sustained for downtime and repairs in case of fault are lower than the investment required for maintenance program. This strategy may be cost-effective until catastrophic faults occur.

Preventive maintenance: maintenance carried out at predetermined intervals or according to prescribed criteria, aimed at reducing the failure risk or performance degradation of the vehicle. The maintenance cycles are planned according to the need to take the device out of service. The incidence of operating faults is reduced.

Risk-based maintenance: maintenance carried out by integrating analysis, measurement and periodic test activities to standard preventive maintenance. The gathered information is viewed in the context of the environmental, operational and process condition and process condition of the equipment in the system. The aim is to perform the asset condition and risk assessment and define the appropriate maintenance program. All equipment displaying abnormal values is refurbished or replaced. In this way it is possible to extend the useful life and guarantee overtime high levels of reliability, safety and efficiency of the plant.

Condition base maintenance: maintenance based on the equipment performance monitoring and the control of the corrective actions taken as a result. The real actual equipment condition is continuously assessed by the online detection of significant working device parameters and their automatic comparison with average values and performance. Maintenance is carried out when certain indicators give the signaling that the equipment is deteriorating and the failure probability is increasing. This strategy, in the long term, allows reducing drastically the costs associated with

maintenance, thereby minimizing the occurrence of serious faults and optimizing the available economic resources management.

2.2.3 Concept of Automobile mechatronics system in modern vehicle

Since the introduction of automobile more than a century ago, the automobile has been in a state of continuous development in response to society's needs and expectations. It continues to evolve today in line with contemporary requirements, not only as a vital element in global economic activity as a means of commercial and passenger transport, but also as a means of enhancing people's lives. As a result of its constant evolution, the automobile is today a comfortable and convenient means of transportation that offers greater safety than ever before and significantly reduced environmental impact, in addition to highly improved operational performance, particularly in the areas of safety, environmental performance and user convenience (Tom, 2006). Major progress has been made; thanks to break through in vehicle-based electronic technologies, engine technologies and in the information and communication technologies that underpin Intelligent Transport Systems (Allan,2001).

Advanced and expanded applications are expected in the future. For the purpose of this study is to introduce and explain these state of the art technologies, focusing on those which are currently in application and developments or applications anticipated for the near future are referred to.

Modern vehicles rely increasingly on electronics for all aspects of their performance, and so electronics is a vital part of the training for Automobile technology lecturers. Mechatronics (Automotive Electronics) is simply a convenient name for this important subject, covering all areas where electronic technology is used in motor vehicles. The definition of Mechatronics can

be divided into two kinds: one is the automotive electronic control devices which were integrated with the mechanical system in the vehicle applications (Allan, 2001).

Automotive electronic control is a combination of mechanical and electrical devices, they include engine power sensor, system control, acceleration, pressure or temperature, electromechanical control, X-by-wire, electronic fuel injection systems, ABS, skid control, electronic control suspension, electronically controlled automatic transmission, the other kind is the on board Mechatronic devices which are electronic devices that can be operated independently in a car environment, they are not directly related to the automobile's performance, safety or control they include integrated on board machines, satellite navigation systems, audio-visual entertainment systems, etc.

Mechatronic components include integrated circuits (IC) components, central processing units (CPU), memory, micro-processor controller, various sensors, and other basic components. A wide range of automotive electronics industry includes six areas: engine/transmission system (such as electronic ignition system, automatic transmission, etc.), suspension/chassis system (including power steering, chassis control, ABS braking system, etc.), car body systems (including lamps, air conditioning, sunroof, etc.), on board information and communications, active or passive safety systems (airbags, anti-collision radar, etc.), and anti-theft security system (Rajeev,2011).

New subjects are arising from the production programme of the car industry, already involved in a transformation of the electrical control system used in cars. New service devices have been introduced and many of the older mechanical controls have been replaced with electrical or electronic ones for some years now. Using innovative technologies likemicroelectronics,

telematics, software offers higher safety and comfort, besides improvingenergy saving and reducing pollution levels for a better environmental care. Automobiletechnologies have been continuously developed in wider fields. These include technologieswhich consider environmental issues and fuel consumption as typically represented by theincrease in the number of hybrid automobiles newly developed, digital technologies whichhave been increasingly incorporated in consumer-electronics products, and technologies tosupport social infrastructure.

The Japan Automobile Manufacturers Association (JAMA, 2009) explains this state of the art of technologies, focusing on those which are currently in application in Japan. Developments or applications anticipated for the near future. Applications of technologies for greater safety, improved environmental performance and increased user convenience which are currently in-use on passenger cars.

2.2.4 Challenges in the maintenance of automobile mechatronics system in electronic control unit of modern vehicles

Nowadays 90% of all product innovation in the automotive industry is driven by electronics and software. Up to 40% of a vehicle's development costs are determined by these components (AUTOSAR, 2013). Due to recent major trends in this industry sector, such as autonomous driving and green propulsion systems, there is still scope for this percentage to increase. Even a modern low-end car has dozens of integrated electronic control units (ECUs) that are connected to each other using fast communication techniques. Furthermore, premium cars can run with around 100 million lines of code, executed on about 100 microprocessor-based electronic control units, that's 15 times the amount of software implemented in the ECUs of a Boeing 787

Dreamliner. The current S-class Mercedes-Benz requires over 20 million lines of code for the radio and navigation system alone.

Experts from the automotive industry predict that the software in cars will continue to grow in both amount and complexity (Charette, 2009). Moreover, new driver assistant functions and multimedia applications demand that the car is connected to its environment. Away from the electronics and software view, functional safety has been a major concern for several years now, but with the trend of connecting the vehicle with its environment, security also becomes more important and requires the development of so-called dependable systems.

The ever growing amount of software and complexity in modern passenger cars is obviously a challenge for all parties involved in the development cycle of an embedded automotive system, irrespective of a particular company's size. But typically small and micro sized entities are not supposed to develop a complete car on their own. Instead, these small teams most likely have a high level of expertise in developing a certain component, which may be delivered to a tier-1 supplier or an original equipment manufacturer (OEM).

In the author's opinion, the small entities involved in the vehicle development cycle should be aware of the mentioned complexity but do not have to cope with it directly. Usually their customer (tier-1 or OEM) is responsible for integrating the system and has to breakdown the complexity through well-deemed requirements and interfaces for the particular product. The definition of sound engineering processes, which is one of the major aspects of this thesis, is crucial for being capable of delivering the mentioned components and the related embedded automotive electrical and/or electronic systems (E/E systems). Moreover, it is a vital basis for the development of the previously mentioned dependable systems. Hence, one of the major

challenges for small entities is to acquire a strategy to quickly enter into the world of engineering processes. Unfortunately, this is not done with selecting an appropriated process reference model. A for all parties involved practicable support, e.g. by means of tools, has to be established.

Many research projects have been carried out to propose such adequate methodologies and tools to support the development of electronic systems. Most of them agree on model-driven strategies as best practice when designing the different development artefacts. One of the key challenges is to keep these artefacts consistent and to assure traceability between them, which is often approached by a virtually automated model to model transformation and code generation. Usually the focus of these methodologies is purely on solving the engineering task without considering non-technical aspects such as the size of the development team. The research work described in this thesis aims to remedy this issue and proposes an approach for the facilitation of mechatronic system development within small entities.

2.2.5 Challenges in the maintenance of automobile mechatronics system in electronic ignition system of modern vehicles

Wilcox (2013) stated that the ignition system is used on gasoline engines to start combustion. An ignition system is needed on gasoline engines to ignite the air-fuel mixture. It produces an extremely high voltage surge, which operates the spark plugs. A very hot electric arc jumps across the tip of each spark plug at the correct time. This causes the air-fuel mixture to burn, expand, and produce power. In the opinion of Vineet (2004), the fundamental purpose of ignition systems is to supply a spark inside the cylinder, near the end of the compression stroke to ignite the compressed charge of air- fuel vapour. Bonnick (2001) stated that without a good quality spark, in the right place at the right time, the engine performance will be affected, as will the

operation of the emissions control system. A misfire can lead to unburnt fuel reaching the exhaust and this will quickly harm the catalyst, often irreparably. For this reason, modern systems monitor the performance of each cylinder, in relation to combustion. One method of doing this is to sense the angular acceleration of the engine flywheel; a firing cylinder will produce more acceleration than a misfiring one. In order to identify the cylinder that is misfiring, the electronic control module (ECM) requires a reference signal and this is often provided by the camshaft position sensor.

In modern automobile systems, the ECM has the ability to detect misfires because the unburnt fuel that results can cause serious damage to the exhaust catalyst. The ECM achieves this diagnosis by reading the time interval between pulses from the crankshaft speed sensor. Persistent misfires will activate the MIL and a fault code (DTC) will be recorded. Urgent remedial work will then be required if serious catalyst damage is to be avoided (Bonnick, 2001).

Today's ignition systems do not use a distributor. Instead, these systems have several ignition coils, one for each spark plug or pair of spark plugs. When a coil is activated by the electronic control module, high voltage is sent through a spark plug circuit. The electronic control module has total control of the timing and distribution of the spark-producing voltage to the various cylinders. A distributor is driven by a gear on the camshaft at one-half the crankshaft speed. It transfers the high-voltage surges from the coil to spark plug wires in the correct firing order. The spark plugs wires then deliver the high voltage to the spark plugs, which are screwed into the cylinder head. The voltage jumps across a space between two electrodes on the end of each spark plug and causes a spark. This spark ignites the air-fuel mixture.

According to (Vineet, 2004)**,** the electronic ignition system should provide the spark to ignite the air-fuel vapour with proper timing depending on speed, load, temperature etc. The spark plug must fire at the correct time during the compression stroke. A crankshaft position sensor or a distributor operates the ignition module. The module operates the ignition coil. The coil produces high voltage for the spark plugs. With the ignition switch on and the engine running, the system uses sensors to monitor engine speed and other operating variables. Sensor signals are fed to the control module. The control module then modifies and amplifies (increases) these signals into on-off current pulses that trigger the ignition coil. When triggered, the ignition coil produces a high voltage output to fire the spark plugs. When the ignition key is turned off, the coil stops functioning and the spark-ignition engine stops running. The following are the challenges faced by automobile mechanics in the maintenance of automobile mechatronics system in electronic ignition system of modern vehicles;

i. Identify the on-board diagnostic port in modern vehicles.
ii. Connect the diagnostic device to the 16-pin on-board diagnostic connector.
iii. Retrieve transmission Diagnostic Trouble Codes (DTC's).
iv. Record and print transmission diagnostic trouble codes
v. Interpret ignition Diagnostic Trouble Codes (DTC's).
vi. Check the crankshaft (CKP) and camshaft (CMP) sensors and their wiring for damage.
vii. Record ignition timing using digital multimeter.
viii. Carry out throttle cable inspection and adjustment.
ix. Check the crank sensor using diagnostic tool.
x. Perform magnetic sensor testing.

xi. Inspect, adjust or replace faulty crank position sensor.

xii. Test and diagnose defective reluctor sensor.

xiii. Check supply voltages and signals with multimeter and oscilioscope.

xiv. Use plug wire or adapter to check for spark.

xv. Conduct a careful visual inspection of the wiring and the mechanical components.

xvi. Check the battery to make sure there is ample voltage to start the engine.

xvii. Inspect, repair and replace faulty electronic ignition components.

xviii. Conduct engine performance test using engine analyzer and determine needed repair.

xix. Test run the ignition system using the multimeter

2.2.6 Challenges in the maintenance of automobile mechatronics system in transmission system of modern vehicles

A transmission basically transfers the power from a car's engine to drive shaft and the wheels. The gears present inside the transmission change the drive wheel speed and torque in relation to the engine speed and torque (pulling power), Lower gear ratios helps the engine to build up enough of power so that the car can easily accelerate from a halt. The transmission is a device that is connected to the back of the engine and sends the power from the engine to the drive wheels. According to Mayur (2012), an automobile engine runs at its best at a certain RPM (Revolutions per Minute) range and it is the transmission's job to make sure that the power is delivered to the wheels while keeping the engine within that range. Automotive transmission is a key element in the power train that connects the power source to the wheels of a vehicle. The purpose of the transmission or transaxle is to use gears of various sizes to give the engine a mechanical advantage over the driving wheels. The following are the challenges faced by

automobile mechanics in the maintenance of automobile mechatronics system in transmission system of modern vehicles;

i. Identify the on-board diagnostic port in modern vehicles
ii. Connect the diagnostic device to the 16-pin on-board diagnostic connector
iii. Retrieve transmission Diagnostic Trouble Codes (DTC's)
iv. Record and print transmission diagnostic trouble codes
v. Interpret Diagnostic Trouble Codes (DTC's)
vi. Conduct thorough visual inspection on transmission linkage Adjustments
vii. Inspect and adjust the shift cable
viii. Examine fluid level for leakage from the transmission vent
ix. Check transmission fluid and filters for oxidation or Contamination
x. Check drive train for looseness or leaks
xi. Remove and reinstall new gasket to correct fluid leakage
xii. Check torque converter for leaks
xiii. Replace leaking or damaged torque converter
xiv. Check transmission vent for blockage
xv. Replacement of O-ring and gears
xvi. Inspect entire transmission wiring harness for tears and other Damages
xvii. Replace damaged fluid lines and fittings
xviii. Careful inspection of a disassembled transmission to diagnose noise and vibration problems

xix. Carry out stall test to check the holding capacity of the converters stator overrunning clutch assembly

xx. Carry out road test for proper gear engagement

Servicing Modern Automobile Engine and its Support Systems

Servicing of the modern automobile engine and its essential system/components include all preventive routine maintenance tasks expected to be done on the engine and its support systems. It involves following service manual for inspection of systems and components, testing and adjustments of components change and/or modification of worn out components before any partial or total breakdown of the vehicle occurs. It also include lubrication service (oil lubrication service), and engine tune-up; engine servicing may at times require that the engine is removed and disassembled to enhance engine performance (Erjavec 2004) and (Giri 2010). For the automobile technician to effectively service modern automobile engine and its essential systems/components, Fetherston (2007) stressed that it is necessary to have the knowledge and understanding of how the engine works; He/she should have knowledge of materials, circuit boards, processor chips and computer application. Writers like Starz (2001), Erjavec (2004), Olson (2008) and Giri (2010) pointed out the need to equally be able to read, understand and interpret charts and service manual, read journals and surf the internet for relevant contemporary technological knowledge. These will enable the technician to carry out checklist service on the engine, carry out engine tune-ups, and use modern digital and measuring instruments and tools e.g. he/she should be able to read, understand and interpret pressure gauges, dial gauges and practically use the oscilloscope to set the ignition timing. In addition to these, the automobile technician should possess the following skills; ability to inspect, test and identify wear on the

engine components, ability to inspect, to replace and/or adjust drive belts. The authors further enumerate skills the technician will need for servicing the automobile engine to include ability to inspect cooling system components (radiator, thermostat and hoses), ability to inspect coolant, drain, flush and refill cooling system with recommended coolant. Other skills are ability to perform oil and lubrication services, ability to inspect and adjust cylinder valves, ability to identify and isolate abnormal sounds, ability to remove and reinstall engine cylinder head using correct torque specification, ability to work within stipulated time, ability to identify genuine spare parts, ability to follow procedures, observe and adhere to safe practices like wearing of safety wares and cleanliness. According to Abdullahi (2002), regular service will prolong the life of the automobile engine for optimal performance before any failure occurs and in the case of any failure, it will be easier to diagnose for repairs.

2.2.7 Strategies for facilitating effective maintenance of automobile mechatronics systems in modern vehicles by automobile mechanics

Diagnosis refers to finding out what is the nature and cause of a fault after careful examination or inspection of the entire system (Fetherston 2007). Erjavec (2004) explained diagnosis to be a way of looking at systems that are not functioning properly or the way they should and to find out why. The purpose of diagnosing faults on the modern automobile engine and its essential systems/components is to determine needed repairs. Rea (2010) describes diagnosis as the maintenance task that has to do with competencies, which will lead to identifying the nature and cause(s) of any error that inhibits the performance of a system that manifest as faulty components, problems in vehicle performance, unsatisfactory performance or even total failure of the vehicle. Rea (2010) further points out that in diagnostic approach, it is essential, first, for the

technician to get the description of the problem from the owner of the vehicle. He then builds on his basic communication skill, ability to analyse issues, make decision, test and examine the systems and components concerned to ensure their functionality. Giri (2010) points out that there are varieties of diagnostic equipment and tools that suit each situation which range from basic electrical diagnosis to engine systems analysers and On-Board- Diagnoses (OBDs).

Therefore, for a technician to diagnose faults on the engine and its supportive sub-systems he must have an understanding of how the system works and how it should work or else it will be difficult to understand what diagnosis is or even how to diagnose any problem on the modern automobile engine. Erjavec (2004) enumerates the seven steps as a general guide to diagnosing of faults on the modern automobile engine as follows:

1. Gather information about the problem,
2. Verify that the problem exists
3. Thoroughly define what the problem is and when it occurs
4. Research all available information and knowledge to determine the possible cause(s) of the problem
5. Locate the problem by testing
6. Continue testing to pinpoint the cause(s) of the problem and
7. Locate and repair the problem then verify the repair.

Bellis, (2010) noted that on some of the modern automobiles with computerised engine controls have self-diagnostic systems. This, according to the author, makes diagnosis on such vehicles much easier. However, it will take a skilful technician to carry out such diagnoses.

Skills for diagnosis of faults in the modern automobile engine and its supportive systems will include the following: ability to communicate clearly with vehicle owners read and understand journals to update knowledge on latest technological development in automobile. Others are ability to read and understand blue prints/technical drawings, and charts, think critically and to possess investigative attitude, and have initiative. Others include ability to handle well modern diagnostic equipment (i. e. perform On-Board- Diagnoses (OBD)), ability to critically analyse and interpret faults from diagnosis results. There is need for knowledge of computer controls on the engine and other systems, knowledge and understanding of how the engine and other systems work. Others are ability to conduct engine testing, inspection and examination, ability to inspect components and the systems essential to engine performance for wear e.g. lubrication system and components, ignition system and components, fuel system and components, cooling system and components and starter circuit and components. Others are ability to conduct engine performance test using engine analyser, ability to distinguish abnormal sounds in the engine and localise such sounds to specific components or systems, ability to determine confidently needed repairs on components and systems being diagnosed. These skills include ability to select the right tools for the expected repairs, and ability to observe safe diagnostic procedures and regulations (Wyman 2007, Oslon 2008, Howells 2008 and Giri 2010). In modern approach to maintenance, repairs follow diagnosis. A repair is a corrective measure that remedies the problem and brings the vehicle back to life and optimal performance (Erjavec 2004 and Giri 2010).

2.3 Review of Related Empirical Studies

Yavala (2010) conducted a study to determine the work skills improvement need of graduates of technical colleges in motor vehicle mechanic practice for employment in modern Nigeria. The

study was carried out in Taraba state of Nigeria. Three research questions were formulated to guide the research study. The study adopted a survey research design and the population of the study consisted of 40 graduates of motor vehicle mechanic practice from industries in the study area. There was no sample for the study, since the population was manageable. A structured questionnaire containing 43 work skill items was used for the collection of data from the respondents. The work skill questionnaire was divided into skills needed and performance with each having a 4-point response scale and a corresponding value of 4,3,2,1 for the two groups respectively. Split half method was employed to determine the internal consistency of the work skills questionnaire item with a reliability coefficient of 0.83. The instrument was analyzed using weighted mean and improvement needed index (INI). Findings of the study revealed that graduates of motor vehicle mechanics practice from technical colleges need improvement in work skills for engine engine maintenance, steering and braking system and auto electricity in order to be employed in Taraba state. The study therefore recommended that all the identified work skills in engine maintenance, steering and braking system and auto electricity should be integrated into the curriculum of motor vehicle mechanic practice in technical colleges for training students.

In a related study carried out by Ogbuanya&Fakorede (2009) to ascertain the technical skills improvement needs of metal work technology teachers for entrepreneurship in response to Millennium Development Goal (MDG) for quality assurance, 16 technical colleges offering metal work technology in Lagos and Ogun states were used for the study. Three research questions were formulated to guide the study. A structured questionnaire was used to collect relevant data from 110 metal work teachers. Data collected were analyzed using the statistical

mean and standard deviation. Cronbach Alpha Reliability technique of 0.98 was established for the instrument. The findings of the study revealed that metal work technology teachers in technical colleges need modern metal work technology skills for quality training of metal work technology students in technical colleges for occupation in metal work industry and productive self-employment. The recommendations of the study among others include the organization of an extensive training for metal work technology teachers in technical colleges in Lagos and Ogun states to keep them abreast with the contemporary practices as well as update their skills in metal work technology; the management of metal work industries and in-house personnel should be co-opted to consolidate teachers teaching with actual work experience.

Doka (2007) also investigated the knowledge and skills needs of technical college graduates for self-employment in metalwork trades in FCT and Nasarrawa state. Three research questions were designed for the study. Three hypotheses were postulated to guide the study and were tested at 0.05 level of significance. A survey research was adopted for the study. The total population of 124 respondent consisting of 45 metal work trade teachers, 39 welding and fabrication, 21 mechanical engineering and 19 foundry craft practice self-employed technical college graduates. A 95 item structured questionnaire and five point likert scales was used as instrument for data collection after being subjected to face validation by three lecturers. The reliability coefficient of the instrument was 0.87 using cronbach alphas. Mean and standard deviation were used to answer the research question while t-test was used to test the hypotheses.

A structured questionnaire was used to elicit information from 45 metalwork trade teachers, and 79 self-employed technical college graduates. The findings of the study showed that few technical college graduates of metal work trades are self-employed in the study area. Based on

these findings, the study recommends that the identified technical knowledge and skills needs of technical college graduates should form the basis for planning and teaching metal work trades namely, welding and fabrication, mechanical engineering practice and foundry craft practice. The State Ministry of Education and Federal Capital Territory education secretariat should fund and provide facilities needed to enhance the effective acquisition of tech knowledge and skills in the teaching-learning process. The study is related to the current study in the aspect of skills. However, it differs in the sense that Doka's study is focused on technical college graduates of metalwork while the present study is aimed at Motor Vehicle Mechanic's Work graduates in technical colleges.

Nwokolo (2010) conducted a study on training skills relevant for employment in metalwork industries in Nigeria: the way forward. Three research questions and three hypotheses were formulated to guide the study. A total of 105 technical teachers were involved in the study. The instrument used for the study was Metalwork Skill Training Questionnaire (MWSTQ). T-test statistical tool was used in the analysis of data. The findings showed that the young graduates need broad based technical skills which can be adapted to rapidly changing economic requirements as well as appropriate basic skills which they can benefit from. The recommendation of the study is that governments in collaboration with non-governmental and international organizations should provide funds for the purchase of adequate number of equipment, tools and materials to facilitate skills acquisition. The study is related to the present study in the aspect of skills. Although, Nwokolo's study is based on training skills for employment, the present study is aimed at identifying emerging technology skills required by Technical College graduates of MVMW for establishing automobile enterprises.

Odigiri& Ede (2010) also carried out a study on the integration of new technological innovations in automobiles into the curriculum of Nigerian Technical College programmes. The area of the study was Benue, Enugu and Kaduna states. The population of the study comprised of 81 subjects made up of all mechanical engineering or technology staff of the two automobile plants and auto-mechanic teachers in the technical colleges in these selected states. The entire population was used for the study. The instrument for data collection was a 41 item structured questionnaire designed by the researcher based on the research questions used for the study. The findings of the study revealed that 41 new innovations comprising of 10 in the engine; 11 in the transmission, suspension, steering and braking systems; 20 in the electrical/electronic and auxiliary systems were rated as important to be integrated into the curriculum. Included among these prominent new automobile innovations are: electronic fuel injection system (EFI), electronic ignition system, variable valve timing intelligence (VVV-i), super charging, emission control systems, On-Board Diagnostic system, All Wheel Steering System (AWS), All Wheel Driving System (AWD) and Anti-lock Braking System (ABS) etc. The findings of this study also revealed that there is a significant difference in the mean responses of industrial workers and technical teachers on five of the identified new technological innovations in automobiles for which the null hypotheses were rejected. These items included the On-Board Diagnostic system, safety airbags and airbag curtains, automatic front windscreen wiper, automatic headlight brightness switch and multiplex wiring. Based on the findings and implications of the study, recommendations were made. These recommendations are as follows: Further studies should be conducted to identify all the other elements of the new innovations needed for the development of comprehensive curricular contents including the skills and theoretical contents entailed in their study as well as

the new tools and equipment needed. The curriculum for teacher training programmes should be reviewed to include these innovations in order to prepare teachers who will be able to implement the curriculum with the new contents for the technical college programmes. The study is related to the current study in the aspect of new technological innovations in automobiles, though the study was conducted on mechanical staff of automobile plants and technical college teachers, the present study will be conducted on industrial supervisors, mechanics and instructors in modern automobile workshops and technical colleges.

Igwe (2011) carried out a study on competency improvement needs of Teachers in On- Board Diagnostic System for effective teaching of petrol engine maintenance in technical colleges in Nigeria. The area of the study was South-Eastern Nigeria. Eight research questions were formulated for the study in line with the components of OBD system which include: input devices, Output devices, Diagnostic Software and Diagnostic tools. Survey research and Borich needs assessment model design was used in the study. The population of the study comprised of 50 subjects made up of MVMW teachers who responded to a 53 item structured questionnaire designed by the researcher. The entire population was used. Three experts face validated the content of the instrument. Cronbach Alpha coefficient of reliability of 0.93 was established for the instrument. The major findings of the study revealed that teachers of MVMW in South-East states of Nigeria need skill improvement training in On-Board Diagnostic (OBD) systems for effective teaching of Petrol Engine Maintenance. This is necessary in order to teach the students who will service the petrol engine vehicles that make use of OBD system effectively. Based on the findings, the recommendation among others is that there should be in-service training in OBD system for the teachers of Motor Vehicle Mechanic's Work. Both studies are carried out on

Motor Vehicle Mechanic's Work. However they differ in the sense that Igwe's study identified competency improvement needs of teachers, the present study sought to find out the emerging technology skills required by MVMW graduates. In another work, Abd-El-Aziz &Adio (2012) carried out a study on new technologies of imported used cars needed to be incorporated into Auto-mechanics trade curriculum of technical colleges. Oyo state was used for the study. The population of the study consisted of 29 Auto mechanic teachers from five technical colleges and 241 industry workers who are graduates of technical colleges. Three research questions guided the study. An 89-item structured questionnaire grouped into 3 sections with Cronbach Alpha Reliability coefficient of 0.78, 0.88 and 0.96 respectively sought information on new technologies, tools and equipment and the competencies needed for inclusion into the auto-mechanic curriculum. The major findings in this study showed that out of the fifty items in section 1, forty-six were considered as technologies that should be incorporated into the curriculum while four items were considered as technologies that should not be considered. The study further found out that all the 26 items in section 2 were considered as important to be incorporated into the curriculum for training the students. The study also revealed that all the 13 items in section 3 of the questionnaire were considered as highly needed for inclusion in the technical college curriculum of auto-mechanics trade.

The recommendations of the study include: Auto-mechanics curriculum should be reviewed and updated periodically to reflect new automotive technologies, teaching and learning tools, materials and equipment in technical colleges. In addition, the curriculum for auto mechanics trade in technical colleges should be reviewed to include these new technologies now that transformation is going on in almost all facets of the economy. The finding also buttressed the

need for high premium to be placed on the training and re-training of technical instructors in order to fast track getting them well-groomed and acquainted with principles and methods of imparting the knowledge and skills to the students. Though Abd-El-Aziz &Adio's study was to find out new technologies of imported used cars needed to be incorporated in the Auto mechanics trade curriculum of technical colleges, the present study seeks to identify the emerging technology skills required by technical college graduates of MVMW in establishing automobile enterprises.

2.4 Summary of related literature

The tasks expected of the automobile mechanic are satisfactorily service the automobile engine and its support systems, exhaustively diagnose any faults, and to completely repair or fix any problem on mechatronic system of modern automobile and its entire component. However, observation revealed that the majority of the automobile mechanics have deficiency in the skills needed to carry out all round maintenance, which are the indices for effective maintenance on mechatronic system in modern automobile. This study was therefore, carried out to determine the challenges faced by automobile mechanics in Niger State regarding maintenance of mechatronic systems for effective maintenance of modern automobile. This calls for a concerted effort by all stakeholders to improve this trend, which has left the automobile maintenance sector at a rudimentary level with obsolete skills possessed by the maintenance mechanics. Efforts would have to be made to enhance the machinery of training and retraining of teachers, lecturers and instructors as well as the practicing automobile mechanics.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Design of the Study

The study adopted a descriptive survey research design. According to Gall, Gall and Borg, (2007), a descriptive survey is a method of collecting data using questionnaires and interviews to collect data from a sample that has been selected to represent a population to which the findings can be generalized. Also, Nworgu (1991) defined descriptive survey research as one in which a group of people or items are studied by collecting and analyzing data from only a few people or items considered to be representative of the entire group, or by collecting and analyzing data from the entire people or item.Descriptive survey research design is suitable for this study because, this design was adopted for this study because it enables the researcher to elicit information from the entire population.

3.2 Area of the Study

This study was carried out in FCT-Abuja. Abuja is the Federal Capital Territory of Nigeria. The study will cover automobile mechanic workshop in Abuja Metropolis in FCT.

3.3 Population of the Study

The target population from this study is one hundred (100) vehicle users and fifty (50) automobile mechanics primarily regarding the challenges automobile mechanics faced in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis.

3.4 Sample and Sampling Technique

The total sampling figure of (70) respondents which includes 20 Automobile Mechanics and 50 vehicle owners was used for the study, and a purposive sampling technique was used.

3.5 Instrument for Data Collection

The basic instrument used for collecting data for the study was a well structured questionnaire titled: the challenges faced by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis. The questionnaire consists of 42 skill items, developed after review of available literature and expert opinion. The questionnaire was divided into two sections (A and B,). Section A contains the preliminary information of the respondents. Section B is further divided into three parts based on the three research questions. Research question one contains 20 items designed to identify the skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles; research questions two has 11 items for identifying the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles. Research question three was made up of 11 items designed to find out the skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles, skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles.. The questionnaire items was assigned a four-point response scale option of Strongly Agreed (SA) Agree (A), Disagree (D) and Strongly Disagree (SD) with a corresponding value of 4, 3, 2 and 1.

1. Skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles.
2. Maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles.
3. Skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles.

3.6 Validation of the Instrument

To ensure the validity of the instrument, the instrument was subjected to face and content validation by three lecturers in automobile technology option in the Department of Industrial and Technology Education, Federal University of Technology, Minna. Experts was requested to validate the items in terms of: appropriateness of expressional standard, language, suitability, arrangement, sequencing and others. For content validity a test blue print was constructed and to validate for weightings of sub-topics in accordance with the suggested instructional periods in the instructional objectives.

3.7 Reliability of the Instrument

Cronbach Alpha coefficient formula (α) was used to determine the internal consistency of the instrument. It was obtained by administering a single test to 10 Automobile Mechanics and 10 vehicle owners in Minna, Nigeria. The result obtained was 0.76, this indicates that the instrument is reliable.

3.8 Administration of the Instrument

The questionnaire was the instrument used by the researcher for the study. The questionnaire was administered to the respondent by researcher personally visiting the entire automobile workshop

included in the study with a copy of an introduction letter from the project coordinator and after the completion; the collection was carried out by the researcher. Sixty (70) questionnaires was distributed to the respondents.

3.9 Method of Data Analysis

The data analysis techniques employed in this study are basically in two folds: descriptive and inferential statistics. Descriptive statistics include mean and standard deviation wasused to analyse research question one to three. While, the inferential statistic involves the use of T-testwasused to analyse the hypotheses. In determining the opinion of the respondents, Likert Scale wasemployed. This involves weighing and ranking of each respondent opinion on the basis of Strongly Agree (SA) which is ranked 4; Agree (A) which is ranked 3; Disagree (D) is ranked 2, while Strongly Disagree (SD) is ranked as 1. The mean score is derived by dividing the sum responses by the total number of the respondents in the study area.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Research Question One

What are the skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles?

Table 4.1: Mean responses of the respondent on the skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles
N_1= 50, N_2 = 20

S/N	ITEMS	$\bar{X}_A$	SD	Remarks
1.	Skill in performing engine tune-up accurately	2.54	1.27	Required
2.	Time injection pumps to engines accurately in the shop	2.50	1.23	Required
3.	Skill in timing valves to an engine accurately	2.74	1.18	Required
4.	Ccalibrate fuel injection pump accurately	2.51	1.19	Required
5.	Skill in performing ignition timing accurately	2.31	1.23	Not Required
6.	Diagnostic problems on single point fuel injection systems	2.57	1.01	Required
7.	Diagnostic problems on multi point fuel injection systems	2.52	1.17	Required
8.	Skill to overhaul an engine	2.70	1.37	Required
9.	Skill in performing phase angle test accurately	2.80	1.10	Required
10.	Skill in working on lubrication systems	2.59	1.43	Required
11.	Skill in repairing air braking systems	2.27	1.13	Not Required
12.	Skill to fix problems in servo assisted hydraulic system	2.54	1.27	Required
13.	Skills to problems on generating(alternator) systems	2.74	1.18	Required
14.	Skills in installing sensors in the engine management system	2.52	1.19	Required

15.	Skill to fix problems on manual transmission systems	2.31	1.23	Not Required
16.	Skill to fix problems on automatic transmission systems	2.55	1.01	Required
17.	skill in using scan tool for diagnosis	2.52	1.17	Required
18.	skill in fixing problems on water cooling systems	2.70	1.37	Required
19.	skill in fixing problems on air cooling systems	2.80	1.10	Required
20.	Skill to fix problems on vehicle suspension systems accurately	2.59	1.43	Required

Keys: N_1= Number of car owners, N_2= Number of Automobile mechanic.

$\overline{X}_A$ = Mean average of car owners and Automobile mechanic.

SD= Standard deviation of car owners and Automobile mechanic.

Table 4.1 revealed the results on the skills required by roadside automobile technician for servicing anti-lock braking system. It shows that item 1,2,3,4,6,7,8,9,10, 12,13,14,16-20 are required skills with the mean range (2.50-2.74), while item 5,11& 15 are not required skills with mean range (2.27-2.31). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents wasnot too far from the mean and from one another in their responses on the skills requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles.

4.2 Research Question Two

What are the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles?

Table 4.2: Mean responses of the respondent on the maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles.
N_1= 50, N_2 = 20

S/N	ITEMS	$\bar{X}_A$	SD	Remarks
1.	Checking the brake fluid level of your car	2.56	1.21	Required
2.	Have you once experience low brake fluid from your car?	2.70	1.25	Required
3.	Check the engine oil in the morning before starting the vehicle	2.54	1.23	Required
4.	Open the radiator cap for coolant level if the engine is over heated	2.57	1.02	Required
5.	Check for low coolant level	2.53	1.05	Required
6.	Check power steering fluid level	2.77	1.08	Required
7.	How often do you experience low power steering fluid	2.51	1.10	Required
8.	Checking steering stiffness in your car	2.58	1.20	Required
9.	Checking of corrosion or sign of leaks around the battery	2.56	1.09	Required
10.	Checking of excess discharge of the battery without the engine running	2.56	1.21	Required
11.	Check the air filter for dirt and debris	2.70	1.25	Required

Keys: N_1= Number of car owners, N_2= Number of Automobile mechanic.

$\bar{X}_A$ = Mean average of car owners and Automobile mechanic.

SD= Standard deviation of car owners and Automobile mechanic.

Table 4.2 revealed the results on the maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles. It shows that all the item are required maintenance approach with the mean range (2.51-2.77). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.25, each of these values

was less than 1.96 indicated that respondents was not too far from the mean and from one another in their responses onthe maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles.

4.3 Research Question Three

What are the skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles?

Table 4.3: Mean responses of the respondent on the skill required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles.
N_1= 50, N_2 = 20

S/N	ITEMS	$\bar{X}_A$	SD	Remarks
1.	Auto scan tool using the appropriate connector for the vehicle	2.64	1.02	Required
2.	Connect the Launch code reader professional	2.60	1.21	Required
3.	Turn on the vehicle ignition	2.64	1.20	Required
4.	Run the Launch code reader professional auto scan tool diagnostic program	2.61	1.19	Required
5.	Navigate through vehicle engine system to access the diagnostic trouble codes from the vehicle electronic control module	2.51	1.27	Required
6.	Record your findings for the engine system	2.67	1.01	Required
7.	Check what the engine system code meant	2.62	1.17	Required
8.	Try fault indicated by the trouble codes need to be corrected before you clear the codes	2.72	1.37	Required
9.	Carryout the repair of the engine system (Adjust spark plugs to current specification, complete engine turn-up, overhaul the fuel pump, set ignition timing and clean & set contact breaker point in distributor)	2.81	1.10	Required
10.	Select the delete code option on the Launch code reader professional 123 auto scan tool to clear fault code	2.53	1.43	Required
11.	Turn off the Launch code reader professional 123 auto scan tool and disconnect from the access point	2.68	1.02	Required

Keys: N_1= Number of car owners, N_2= Number of Automobile mechanic

$\bar{X}_A$ = Mean average of car owners and Automobile mechanic

SD= Standard deviation of car owners and Automobile mechanic

Table 4.3 revealed the results on the skill require by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles. It shows that all items agreed on the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles mean range (2.51-2.74). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents was not too far from the mean and from one another in their responses on the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles.

4.4 Hypothesis One

There is no significant difference in the mean rating of automobile mechanic and car users on the skills requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis.

Table 4.4: T-test Analysis of Mean Difference between Responses of car users and automobile mechanics on the skills requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis

	N	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval for Difference Lower	Upper
Car Users	50	0.47	0.65	68	0.03	0.09	0.14	0.18	0.36
Automobile mechanics	20		0.66		0.03	0.09	0.14	0.18	0.36

Table 4.4 shows the t-test analysis of differences in the responses of automobile mechanic and car users on the skills requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles. The table reveals that the significant criterion (sig. 2-tailed) was found to be 0.03 which is less than the level of significance 0.05 in comparison. The null hypothesis was therefore rejected. Therefore, there was a significant difference between the mean responses of automobile mechanic and car users on the skills requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles.

4.5 Hypothesis Two

There is no significant difference in the mean rating of automobile mechanic and car users on the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles in Abuja metropolis.

Table 4.5:T-test Analysis of Mean Difference between Responses of car users and automobile mechanics on the maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles in Abuja metropolis

	N	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval for Difference	
								Lower	Upper
Car Users	50	0.42	0.62	68	0.01	0.05	0.14	0.23	0.28
Automobile mechanics	20		0.59		0.01	0.05	0.14	0.23	0.28

Table 4.5 shows the t-test analysis of differences in the responses of automobile mechanic and car users on the skills requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles. The table reveals that the significant criterion (sig. 2-tailed) was found to be 0.01 which is less than the level of significance 0.05 in comparison. The

null hypothesis was therefore rejected. Therefore, there was a significant difference between the mean responses of automobile mechanic and car users on the maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles in Abuja metropolis

4.6 Hypothesis Three

There is no significant difference in the mean rating of automobile mechanic and car users on the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles in Abuja metropolis.

Table 4.6: T-test Analysis of Mean Difference between Responses of car users and automobile mechanics on the maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles in Abuja metropolis.

	N	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval for Difference Lower	Upper
Car Users	50	0.24	0.15	33	0.01	0.02	0.14	0.29	0.25
Automobile mechanics	20		0.15		0.01	0.02	0.30	0.29	0.25

Table 4.6 shows the t-test analysis of differences in the responses of automobile mechanic and car users on the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles in Abuja metropolis. The table reveals that the significant criterion (sig. 2-tailed) was found to be 0.01 which is less than the level of significance 0.05 in comparison. The null hypothesis was therefore rejected. Therefore, there was a significant difference between the mean responses of automobile mechanic and car users on the

skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles in Abuja metropolis.

Findings of the Study

1. The skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles include among others skills in performing engine tune-up, ignition timing, performing phase angle test, repairing of braking system, repairing alternators, repairing transmission system as well as overhauling power steering system.
2. The maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles includes checking the brake fluid level of your car, checking the engine oil in the morning before starting the vehicle, opening the radiator cap for coolant level if the engine is over heated, checking power steering fluid level, checking steering stiffness in your car as well as checking the air filter for dirt and debris.
3. The skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles Connecting the Launch code reader professional auto diagnostic scan tool to the diagnostic port, run the Launch code reader professional auto diagnostic scan tool program, navigating through vehicle engine system to access the diagnostic trouble codes from the vehicle electronic control module, recording your findings for the engine system as well as interpreting trouble codes.

4. There is no significant difference in the mean rating of automobile mechanic and car users on the skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis.
5. There is no significant difference in the mean rating of automobile mechanic and car users on the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles in Abuja metropolis.
6. There is no significant difference in the mean rating of automobile mechanic and car users on the skill required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles in Abuja metropolis.

4.7 Discussion of Findings

The result revealed on the skills required by roadside automobile technician for servicing anti-lock braking system. It shows that item 1,2,3,4,6,7,8,9,10, 12,13,14,16-20 are required skills with the mean range (2.50-2.74), while item 5,11 & 15 are not required skills with mean range (2.27-2.31). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents were not too far from the mean and from one another in their responses on the skills requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles. The findings of the study is in line with Yavala (2010) conducted a study to determine the work skills improvement need of graduates of technical colleges in motor vehicle mechanic practice for employment in modern Nigeria. The study was carried out in Taraba state of Nigeria. Three research questions were formulated to guide the research study. The study adopted a survey research design and the population of the study consisted of 40 graduates of motor vehicle

mechanic practice from industries in the study area. There was no sample for the study, since the population was manageable. A structured questionnaire containing 43 work skill items was used for the collection of data from the respondents. The work skill questionnaire was divided into skills needed and performance with each having a 4-point response scale and a corresponding value of 4,3,2,1 for the two groups respectively. Split half method was employed to determine the internal consistency of the work skills questionnaire item with a reliability coefficient of 0.83. The instrument was analyzed using weighted mean and improvement needed index (INI). Findings of the study revealed that graduates of motor vehicle mechanics practice from technical colleges need improvement in work skills for engine maintenance, steering and braking system and auto electricity in order to be employed in Taraba state. The study therefore recommended that all the identified work skills in engine maintenance, steering and braking system and auto electricity should be integrated into the curriculum of motor vehicle mechanic practice in technical colleges for training students.

The result revealed on the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles. It shows that all the item are required maintenance approach with the mean range (2.51-2.77). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.25, each of these values was less than 1.96 indicated that respondents were not too far from the mean and from one another in their responses onthe maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles. The findings of the study is in line with Doka (2007) also investigated the knowledge and skills needs of technical college graduates for self-employment in metalwork trades in FCT and Nasarrawa state. Three research

questions were designed for the study. Three hypotheses were postulated to guide the study and were tested at 0.05 level of significance. A survey research was adopted for the study. The total population of 124 respondent consisting of 45 metal work trade teachers, 39 welding and fabrication, 21 mechanical engineering and 19 foundry craft practice self-employed technical college graduates. A 95 item structured questionnaire and five point likert scales was used as instrument for data collection after being subjected to face validation by three lecturers. The reliability coefficient of the instrument was 0.87 using cronbach alphas. Mean and standard deviation were used to answer the research question while t-test was used to test the hypotheses. A structured questionnaire was used to elicit information from 45 metalwork trade teachers, and 79 self-employed technical college graduates. The findings of the study showed that few technical college graduates of metal work trades are self-employed in the study area. Based on these findings, the study recommends that the identified technical knowledge and skills needs of technical college graduates should form the basis for planning and teaching metal work trades namely, welding and fabrication, mechanical engineering practice and foundry craft practice. The State Ministry of Education and Federal Capital Territory education secretariat should fund and provide facilities needed to enhance the effective acquisition of tech knowledge and skills in the teaching-learning process. The study is related to the current study in the aspect of skills. However, it differs in the sense that Doka's study is focused on technical college graduates of metalwork while the present study is aimed at Motor Vehicle Mechanic's Work graduates in technical colleges.

The result revealed on the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles. It shows that all items agreed on the skill

requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles mean range (2.51-2.74). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents were not too far from the mean and from one another in their responses on the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles. The study is in line with Igwe (2011) carried out a study on competency improvement needs of Teachers in On- Board Diagnostic System for effective teaching of petrol engine maintenance in technical colleges in Nigeria. The area of the study was South-Eastern Nigeria. Eight research questions were formulated for the study in line with the components of OBD system which include: input devices, Output devices, Diagnostic Software and Diagnostic tools. Survey research and Borich needs assessment model design was used in the study. The population of the study comprised of 50 subjects made up of MVMW teachers who responded to a 53 item structured questionnaire designed by the researcher. The entire population was used. Three experts face validated the content of the instrument. Cronbach Alpha coefficient of reliability of 0.93 was established for the instrument. The major findings of the study revealed that teachers of MVMW in South-East states of Nigeria need skill improvement training in On-Board Diagnostic (OBD) systems for effective teaching of Petrol Engine Maintenance. This is necessary in order to teach the students who will service the petrol engine vehicles that make use of OBD system effectively. Based on the findings, the recommendation among others is that there should be in-service training in OBD system for the teachers of Motor Vehicle Mechanic's Work. Both studies are carried out on Motor Vehicle Mechanic's Work. However they differ in the sense that Igwe's study identified competency

improvement needs of teachers, the present study sought to find out the emerging technology skills required by MVMW graduates.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study assessed the challenges faced by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis. The specific objective of the study is to determine skill requirement by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles, determine maintenance approach to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles and to determine the skill requirement by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles. Three (3) corresponding research questions and null hypotheses were raised. The research design is a descriptive survey, the population of the study comprises of fifty (15) car users and twenty (20) automobile mechanic. The study concluded that most users of automobile, maintenance only comes to mind when their automobile fail; while others see maintenance solely as when repair is required. As a result of this, many vehicles end up broken down on the high way or abandoned in the auto-workshops all around the cities. This explicitly supports the fact that Nigerians, most registered engineers inclusive, lack maintenance culture. For the auto-mechanics, it requires serious re-engineering and training to bring them to align with modern trends in automobile maintenance.

5.2 Recommendations

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

1. The Federal Capital Territory, Abuja authority should organize retraining workshop programme to enable the mechanics acquire the skills required iin the maintenance of automobile mechatronics system in modern vehicles.
2. The National Automobile Technicians Association (NATA) should give orientation and awareness to the mechanics and car users on the most appropriate maintenance approach required to be adopted in the maintenance of automobile mechatronics system in modern vehicles.
3. Automobile maintenance professionals from the automobile industries should be invited from time to time to teach mechanics new and emerging skills required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles.
4. The federal government under the ministry of labour and employment should partner with standard automobile industries to provide funding support in purchasing of modern diagnostic equipment needed in the maintenance of modern vehicles.
5. The car users should acquire basic knowledge on the periodic routine checks to be carried out on modern vehicles to reduce sudden breakdown that may lead to unexpected accident.

5.3 Suggestion for Further Studies

1. Assessment on good maintenance system as a practical class in Technical Colleges Kogi State.
2. Challenges faced by automobile mechanics in the maintenance of auti-lock braking system in modern vehicles in Lagos State.
3. Challenges faced by automobile mechanics in the maintenance of hybrid vehicles system in Kano State.

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APPENDIX A

QUESTIONNAIRE ON THE CHALLENGES FACED BY AUTOMOBILE MECHANICS IN THE MAINTENANCE OF AUTOMOBILE MECHATRONICS SYSTEM IN MODERN VEHICLES IN ABUJA METROPOLIS

Dear respondent,

This Questionnaire is designed to obtain information on challenges faced by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles in Abuja Metropolis. Please, kindly assist by filling the necessary information where appropriate. Any information obtained were held in strict confidence and were used solely for the purpose of this academic study. Please tick or write in the appropriate location.

SECTION A

Automobile Mechanic [ ]

Vehicle users [ ]

HR= Highly Required (4 points)
R= Required (3 points)
MR= Moderately Require (2 points)
NR= Not required (1 point).

SECTION B

ResearchQuestionOne

What are the skills required by automobile mechanics in the maintenance of automobile mechatronics system in modern vehicles?

HR= Highly Required (4 points), R= Required (3 points), MR= Moderately Require (2 points), NR= Not required (1 point).

S/N	ITEMS	HR	R	MR	NR
1	skill in performing engine tune-up accurately				
2	I time injection pumps to engines accurately in the shop				
3	skill in timing valves to an engine accurately				
4	I am able to calibrate fuel injection pump accurately				
5	skill in performing ignition timing accurately				
6	Diagnostic problems on single point fuel injection systems				
7	Diagnostic problems on multi point fuel injection systems				
8	I am able to overhaul an engine				
9	skill in performing phase angle test accurately				
10	skill in working on lubrication systems				
11	skill in repairing air braking systems				
12	skill to fix problems in servo assisted hydraulic system				
13	Skills to problems on generating(alternator) systems				
14	Skills in installing sensors in the engine management system				
15	Skill to fix problems on manual transmission systems				
16	Skill to fix problems on automatic transmission systems				
17	skill in using scan tool for diagnosis				
18	skill in fixing problems on water cooling systems				
19	skill in fixing problems on air cooling systems				
20	Skill to fix problems on vehicle suspension systems accurately				

ResearchQuestionTwo

What are the maintenance approach required to be adopted by car users in the maintenance of automobile mechatronics system in modern vehicles?

SA= Strongly Agree, (4 points), A= Agree (3 points), DA= Disagree (2 points), SD= Strongly Disagree (1 point).

S/N	ITEMS	SA	A	D	SD
1	Checking the brake fluid of your car				
2	Have you once experience low brake fluid from your car?				
3	check the engine oil each time the car is refuelled				
4	open the cooling system if the engine is hot				
5	check low coolant level				
6	check power steering fluid				
7	How often do you experience low power steering fluid				
8	checking steering stiffness in your car				
9	Checking of corrosion or sign of leaks around the battery				
10	Checking of excess discharge of the battery without the engine running				
11	check the air filter for dirt and debris				

HR= Highly Required (4 points), R= Required (3 points), MR= Moderately Required (2 points), NR= Not Required (1 point).

ResearchQuestionThree
What are the skill required by automobile mechanic in diagnosing fault in automobile mechatronics system in modern vehicles?

SA= Strongly Agree, (4 points), A= Agree (3 points), DA= Disagree (2 points), SD= Strongly Disagree (1 point).

S/N	ITEMS	SA	A	D	SD
1.	Auto scan tool using the appropriate connector for the vehicle				
2.	Connect the Launch code reader professional				
3.	Turn on the vehicle ignition				
4.	Run the Launch code reader professional auto scan tool diagnostic program				
5.	Navigate through vehicle engine system to access the diagnostic trouble codes from the vehicle electronic control module				
6.	Record your findings for the engine system				
7.	Check what the engine system code meant				
8.	try fault indicated by the trouble codes need to be corrected before you clear the codes				
9.	Carryout the repair of the engine system (Adjust spark plugs to current specification, complete engine turn-up, overhaul the fuel pump, set ignition timing and clean & set contact breaker point in distributor)				
10.	Select the delete code option on the Launch code reader professional 123 auto scan tool to clear fault code				
11.	Turn off the Launch code reader professional 123 auto scan tool and disconnect from the access point				