UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

THE USE OF DIAGNOSTIC EQUIPMENT IN THE MAINTENANCE SERVICES OF AUTOMOBILES AND ITS IMPACT ON THE WAYSIDE GARAGE (A CASE STUDY IN THE ACCRA METROPOLIS)

FRANCIS AMUI

DECEMBER, 2017

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BY

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DECEMBER, 2017

DECLARATION

STUDENT'S DECLARATION

I, FRANCIS AMUI, declare that this Dissertation with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ……..

DATE: ……

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidance for supervision of Dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: ENGR. C. K. NWORU

SIGNATURE: …….....

DATE: ….....

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DEDICATION

I dedicate this work to my wife, Rita Amui and children, Yehowale Nii Commey Amui and Mawukley Kaaley Amui.

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ABSTRACT

In Ghana, most of the vehicle maintenance and repair jobs are performed by wayside mechanics and they use what is termed the 'try and error' to repair almost all automobile. Based on this the study assesses the use of diagnostic equipment in the maintenance services of automobiles and its impact on the wayside garage in Accra Metropolis. The specific objectives of the study were to: find out the knowledge level of the wayside mechanics on diagnostic equipment, ascertain the reasons car owners send their cars to wayside garages, assess the challenges faced by wayside mechanics in the advent of automobile technology, and determine the effect of diagnostic equipment on the maintenance services of wayside garages in Accra Metropolis. Survey research design was used for this study. Purposive sampling technique was employed to select 186 owners of roadside garage in Accra Metropolis. Questionnaire was used as data collection instrument. The study found that wayside garages do not have adequate diagnostic tools and equipment, and not experienced on the use of diagnostic tools and equipment. The study further indicated that car owners send their cars to wayside garages because of low workmanship charges, good service and can negotiate the service charge.The study revealed that lack of required equipment (OBD scan tool), complexity in the usage of diagnostic scan tools, and lack of proper upgrading are the major challenges faced by wayside mechanics in the advent of automobile technology. Based on this, it was concluded that diagnostic equipment affects customers patronage of services provided by wayside garages, survival of the business and the quality of repairs of wayside garages in Accra Metropolis. It was recommended that wayside mechanics should be given every opportunity to undergo a series of training to upgrade their technical knowledge in the use of the On-Board-Diagnostics tool (OBD).

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Changes in technology have brought about many changes in the type of machines and equipment needed for servicing automobiles. As a result of these changes, equipment requirement have also changed and advanced (Duffy & Scharff, 2003). Technology can be defined as all the knowledge, products, processes, tools, methods and systems employed in the creation of goods or in providing services (Khalil, 2000). Technology and the use of computers have become part of life; things which were done manually centuries ago can now be done technologically with the use of computer (Bennett et al, 2006). Robbins and Judge (2007) stated that no organization or individual can afford to accept current level of performance or competitive pressure will drive them out of business. Individuals must continue to improve upon their technological skills in this technological age. Motor vehicles which were manually operated some centuries back are now electro-mechanically operated. Computers are common place in modern day automobile design; braking, steering, starting and suspensions system are few examples of items now technologically operate (Duffy, 1995).

Automobile technology has been evolving since the turn of the century. Santini (1992) stated that during the period from 1930 to 1970, the main body of automotive technology was mechanical; they were relatively simple for any roadside mechanic to repair. By the early 1980's the introduction of information technology in automobiles has triggered the most rapid technological advancement in the automobile industry. With

computers available, automobile designers have developed numerous sensors and controls. Now computers have even been used as parts for brakes, steering, chassis and other parts of automobile.

Technologies have recently been incorporated in all new automobile subsystems and have become standard implementation on many others. Such features as Antilock Braking System (ABS) and airbag could only be achieved practically through the use of technology. These features are rapidly becoming standard features in all new automobile owing to change in customer's taste for automobile and status symbols attached to car ownership. All these systems require maintenance and repairs. The competency required to maintain automobile of the 1900s show little similarity with the competency required of the 1970s. Lindsay (2013), stated that around 1970s and 1980s wayside mechanics used what is termed the 'try and error' to repair almost all automobiles.

The modern trend of mechanical services therefore requires the use of more complex and highly technological specialty diagnostic equipment to analyze vehicle faults for repair and service. To ensure this for efficiency, safety, comfort, style and so on, competent professional hands are required (Chron, 2014). As vehicle technology and maintenance processes are advancing, the problems facing automobile garages in the country have rather compounded. In Ghana where land transport is largely in use compared to water, air as well as other modes of transportation, the use of automobile vehicles, either diesel or petrol driven is predominant. However, the vehicles cannot remain new forever. A continuous use of the vehicles results in their general wear, tear and breakdowns; and as the parts breakdown and wear out, so, must be maintained (Akinola, 1995). When something is maintained, the idea is to keep it in a good and

functional state. Vehicle maintenance refers to a practice where an automobile is serviced on a regular basis to prevent a major breakdown or the need for major repair. Examples of the type of auto services that may be sought for maintenance purposes include changing the oil, changing the spark plugs, and rotating the tires. It is believed that an automobile vehicle will last longer and operate better if a person adheres to the vehicle maintenance schedule (Akinola & Ogedenge, 2005).

Rapid development of automobile technology has presented some challenges for wayside mechanics in Ghana. Ribbens (1998) noted that the use of scan tools like On-Board Diagnostic, One, Two and Three (OBDI, OBDII, and OBDIII) are common place in the repair of automobiles in the manufacturer's approved service centres today. The on-board diagnostic (OBD) is an automotive term referring to a vehicle's self-diagnostic and reporting capability. OBD systems give the vehicle repairer access to the status of the various vehicle sub-systems and give the mechanic a clue as to where to look at when a problem occurs on the vehicle. But for one to be able to use this tool the mechanic must be able to understand the principles behind its usage.

Looking at the fact that wayside garages in Ghana play an important economic role in providing vehicle maintenance services to numerous car owners, this research aims at assessing the use of diagnostic equipment in the maintenance service of automobiles and its impact on the wayside garage in Accra Metropolis.

1.2 Statement of the Problem

Due to rapid technological development in the automobile vehicle manufacturing industry, it is clear that the challenges confronting those who seek the services of these local garages are enormous. The US Department of Labour statistics (2012) estimated that due to the increasing average lifespan of cars and growth in the number of cars being driven, the department projected the demand for automotive mechanics to increase 9% between 2012 and 2022. Those with specialized knowledge or training will have the best opportunities. The rate of change in technology is exponentially increasing. Ghanaian industries and individuals must develop their capabilities to keep abreast of technological changes and to harness technology.

Currently, it is common knowledge that a large proportion of auto mechanics, both the experienced and trainees, of the wayside garages in Ghana find it extremely difficult to diagnose, repair and maintain modern cars. Indeed, this has worked to the effect that most of the wayside garages in the country are now currently out of business. The problems faced by the wayside garages in country as far as the repair and maintenance of modern cars are concerned could be attributed to reasons such as low technical educational levels of auto mechanics, high cost of operations, lack of diagnostic machines, waste of time in detecting faults, damage to engines without the use of diagnostic machines in detecting faults, lack of appropriate maintenance practices, loss of customers and so on. A visit to wayside garages in Accra Metropolis reveals that vehicle diagnosing, repair and maintenance activities are carried out without sound and state-of-the- art maintenance practices.

In Ghana, most of the vehicle maintenance and repair jobs are performed by wayside mechanics and they use what is termed the 'try and error' to repair almost all automobile. This research assesses the use of diagnostic equipment in the maintenance services of automobiles and its impact on the wayside garage in Accra Metropolis.

1.3 Purpose of the Study

The purpose of the study is to assess the use of diagnostic equipment in the maintenance services of automobile vehicles and its impact on the wayside garage in Accra Metropolis.

1.4 Objectives of the Study

The specific objectives of the study were to:

- Find out the knowledge level of the wayside mechanics on diagnostic equipment in the maintenance services of automobile vehicles
- Assess the challenges faced by wayside mechanics in the advent of automobile technology.
- Determine the effect of diagnostic equipment on the maintenance services of wayside garages in Accra Metropolis.

1.5 Research Questions

The following research questions were developed to guide the study

- What are the knowledge levels of the wayside mechanics on diagnostic equipment in the maintenance services of automobile vehicles?

- What challenges do wayside mechanics faces in the advent of automobile technology?
- How has diagnostic equipment affected maintenance services of wayside garages in Accra Metropolis?

1.6 Significance of the Study

The outcome of this study would provide information on diagnostic equipment in the service delivery of automobiles vehicles. This will give wayside garages in Ghana the insight into automobile technology advancement.

The study is justified for the reason that it might be a good source of information for further studies by researchers on the use of diagnostic equipment in the service delivery of automobiles vehicles. The study will act as a guide to policy makers, the government and administrators as well as all other stakeholders who find diagnostic equipment in the service delivery of automobiles useful.

Finally, this work will be beneficial these to wayside mechanics. It will help them to reveal the challenges faced by these mechanics in the advent of automobile technology advancement and the opportunities available to these wayside mechanics so as to prevent them from becoming career disabled due to increase in vehicle technology.

1.7 Delimitation of the Study

This study sheds more light and deepens the understanding of the issues concerning diagnostic equipment in the maintenance services of automobiles. The study is restricted to wayside garages in Accra Metropolis in Greater Accra Region. The study

covers the knowledge levels of the wayside mechanics on diagnostic equipment, the challenges faced by wayside mechanics in the advent of automobile technology advancement and the effects of diagnostic equipment on the performance of wayside mechanic service delivery.

1.8 Organization of the Study

The research has been organized into five chapters. The First Chapter essentially introduces the research, identifies the key problem under investigation and asks the relevant questions. It outlines the objectives, both general and specific, makes known the significance of the research and states the limitation and delimitation of the study. This chapter is relevant to the study because it puts the study into perspective and helps to check deviation.

The Second Chapter presents a review of relevant literature on diagnostic equipment in the service delivery of automobiles. It takes a looks into the concept of automobile system. It further concentrates on conceptual framework of the study.

Chapter Three provides information on participants, sampling techniques, procedures and equipment used in both data collection, and analysis. It also deals with the research design, description and distribution of instruments.

The Fourth Chapter is dedicated to the results and discussion of the research outcome. Chapter Five gives a summary of the findings, draws conclusions and offers recommendations and any other limitations of the study. This is very relevant because it brings to bare information previously unavailable, thus expanding the frontiers of existing knowledge.

CHAPTER TWO

LITERATURE REVIEW

This chapter presents the relevant literature pertaining to the study: It comprises automobile service industry and the automobile vehicle maintenance and repair service industry in Ghana. The chapter also provides the challenges faced by wayside mechanics in the advent of automobile technology. Finally, this chapter describes the theoretical framework of the study.

2.1 Automobile Service Industry

Automobile technology has been evolving since the turn of the century. Santini (1992) stated that during the period from 1930 to 1970, the main body of automotive technology was mechanical; they were relatively simple for any roadside mechanic to repair. By the early 1980's the introduction of information technology in automobiles has triggered the most rapid technological advancement in the automobile industry. Automotive service industry includes vehicle servicing, repairing, breakdown and recovery services. According to Liou and Chen (2006), literature related to service attributes and the service quality measurement in car service industry can be gained from previous studies on car maintenance services. Starting with 42 attributes, Bouman and Wiele (1992) evaluated the service quality of the Dutch car service industry and concluded that three attributes namely kindness, tangibles and faith can be used in a car service industry against the SERVQUAL instrument's five dimensions. Wiele (1992) explained SERVQUAL as a multi-dimensional research instrument, designed to capture

consumer expectations and perceptions of a service along the five dimensions that are believed to represent service quality.

The quality of service and repair works has become even more important in this time of economic recovery through strengthening customer relationships, attracting lost customers and renewing their confidence in the firm by means of effective service recovery strategies (Lele, 1997). The environment for most of the automobile dealerships is very challenging these days under the massive global market competition

Chen and Ting (2002) conducted a study in automobile repair shops using grey relationship analysis and proved that service quality and customer satisfaction are two different constructs in the minds of the consumers. Ten influencing factors proposed by Parasuraman et al. (1985) have been used to measure the service quality of repair shops. Behara et al. (2002) used neural network for effective service quality measurement in an auto-dealership network at Thailand using 36 parameters. Brito et al. (2007) on the other hand used 30 service attributes to evaluate the Brazilian customers' preference in choosing a branded dealer or an independent garage for providing maintenance service. The results showed that the branded dealers' service operation is relatively weak when compared to independent garages. Among the 30 service attributes, customers preferred branded dealers only for better equipment condition while they preferred independent garages for three service attributes namely value for money, adherence to forecast prices and mechanical reliability. SERVQUAL has been used as a tool to collect the customer preference. All these studies used either SERVQUAL instrument or Likert scale survey questionnaire to collect the data regarding perceived service quality. The statistical analysis of the results gained from the Likert scale survey using traditional methods is

cumbersome. Moreover, the subjective assessment of the service process using SERVQUAL or SERVPERF instruments is intrinsically imprecise and ambiguous (Williams&Zigli, 1987). To reflect the subjectivity and imprecision in the survey, the assessment made by the respondents can be represented as fuzzy sets (Yeh & Kuo, 2003). Liou and Chen (2006) proposed a conceptual model to assess the perceived service quality in a family-owned copy shop using fuzzy set theory and customers' vague linguistic terms. It is proven that the fuzzy linguistic assessment of service quality is much closer to human thinking than methods based on crisp numbers (Benitez et al., 2007).

Automobile Technology has made slow progress from its earliest time to date. However, the introduction of computers and its likes marked the beginning of a new era in Automobile Technology. These include safety airbags, anti-lock braking system (ABS), all wheel driving system (AWD), all wheel steering system (AWS), on board detection and diagnostic system (OBDS). These systems are gradually becoming standards in most of the new automobile models particularly, the federal government new policy restricting the importation of fairly used motor vehicles to those within eight years from their date of manufacture, with the importing of brand new cars with modern technology. The vital responsibility of maintaining these brands of assorted motor vehicles on the roads in good road worthy conditions however rests on the automotive repair industries. They are expected to test, diagnose, service or completely repair faults on motor vehicle to an acceptable standard (Liou & Chen, 2006).

Horovitz, (1990) revealed that customers dissatisfied with a service will divulge their experience to more than three people. This means making the effort to understand

the customer's needs is very important. This includes learning the customer's specific requirements, providing individualized attention and recognizing the regular customer. As per Parasuraman, et al. (1985), the tools to measure service quality are critical application towards understanding and knowing the customer. The dimensions of competence, courtesy, communication, credibility and security formed part of the assurance dimension, access, and understanding and knowing the customer dimensions, formed part of the empathy dimension (Parasuraman et al., 1985).

According to Kotler (2000), service quality perceptions judged by customers will create a competitive advantage. In the motor vehicle service industry the kind of service levels can be a differentiating factor for competition. Kotler's report indicates that favourable service quality perceptions will also impact on profitability as customers are more satisfied with the service offered. In the light of this assertion, it can be said that the Small and Medium Enterprises (SMEs) of the automobile maintenance service industry can offer services that will appeal to the perception of its customers to gain competitive advantage. On the basis of providing quality service, the necessary facilities and equipment as well as the human resource are essential tools for providing the required services.

Zeithaml, Parasuraman, and Berry (1990), through their studies propose that service quality is the discrepancy between customer's expectations and perceptions, that word of mouth, personal needs, experience and external communications influence customer expectations. As affirmed by Bitner, Faranda, Hubbert, and Zeithaml (1997), customers can contribute to the quality, satisfaction and value of the service delivery in that they contribute to their own satisfaction experience. The acceptance of the quality of

service is also improved as chances are good that the customer's expectations are fulfilled (Bitner et al., 1997).

2.2 Automobile Vehicle Maintenance and Repair Service Industry in Ghana

Mechanics are a key human resource in the automobile industry in every economy. In developing countries such as Ghana, most mechanics are in the informal sector with a marginal number of them being employed in the formal and government institutions to be in charge of the organization's automobile workshops. Their key roles include maintenance and repair of vehicles. Similar tasks are being performed in India by automobile repair workers. Tasks such as vehicle spraying and painting, repair of vehicle parts, body cleaning, welding services and general work are performed by automobile repairers (Vyas et al., 2011). These activities are not without hazards and therefore it is important to apply safety rules and regulations.

Mechanics in the automobile industry are exposed to a lot of occupational health risks. Some of these risks include exposure to hot noisy environments, presence of dust, fumes, oils, grease and other chemicals, strenuous work postures, the use of improperly designed tools and machinery and working in poor psycho-social environments (Hunt et al., 2000; ILO, 2000; Rongo et al., 2004). Taha (2000) indicated that workers in auto-mechanics, including welders, are exposed to asbestos, metal dust, organic solvents, paint pigments and automobile exhausts, which pose serious risks to their health. Therefore adherence to safety rules and regulation to reduce occupational risks and hazards within the automobile repair workshops is very important.

Almost all industries have safety regulations which help to prevent accidents or reduce it to its barest minimum and this applies to the automobile workshop. This is because the occurrence of accidents within an industry whether fatal or non-fatal causes suffering to the victim(s), wastes funds and resources and time of the industry or owner of the workshop. It is therefore essential for automobile workers to adhere to safety regulations to reduce occupational accidents. Furthermore, studies show that mechanics have higher rates of occupational health hazards compared to workers in other occupations (Valuri & Routley, 1994; Leung, 1998). In developing countries such as Ghana, enforcement of automobile workshop safety regulations is lacking especially the local garages. Most of these workshops are in the informal sector and their owners or supervisors were apprentice trainees. They lack the requisite knowledge in automobile workshop safety regulations. However, automobile workshops of government organizations or institutions are supervised by professionally trained automobile engineers who have appropriate and adequate knowledge in automobile workshop safety. The international automobile companies have standard automobile workshops where safety regulations are maintained and enforced.

A report from International Labour Office shows that hundreds of thousands of accident cases were recorded in workshops (World of Work Report, 2012). These included automobile repair workshops of which some of the accident cases resulted into deaths. However, in developing countries such as Ghana, occupational risk factors in the informal sectors are not well documented. In addition, most of the local artisans working in the informal automobile sector are not well educated and often uninformed regarding safety practices and risks involved in violating these practices. Therefore this study

sought to investigate accidental risk factors within some selected automobile repair workshops in Ghana for adherence and violation of safety rules and regulations.

According to Liou and Chen (2006), the automotive repair and maintenance service is anticipated to grow at a double-digit during the forecast period. Growth of the automotive repair and maintenance service is mainly driven by increasing vehicle production, increasing safety and security needs, demand for add-on services, growing vehicle part, higher customer awareness about vehicle upkeep, periodic maintenance and increasing mandate by governments, among others. However, despite certain technological challenges such as hybrid designs require additional training for mechanics acting as growth restraints, the automotive repair & maintenance services is expected to experience rapid growth over the forecast period.

The global automotive repair and maintenance services market is anticipated to register a favourable growth for the forecast period, 2015-2025. On the basis of region, Asia Pacific is expected to be the growth engine of automotive repair and maintenance services market in the near future. The key countries mentioned in the Asia-Pacific region are China, India and Japan as an outcome of growth in the vehicle population which in turn is resulting in increase in demand of automotive repair and maintenance services in these countries (Leung, 1998). Moreover, the region is expected to generate higher revenue as compared to North America and Europe (maturing markets). Japan also contributes to the global automotive repair & maintenance services market remarkably. Moving forward towards the developing regions, Latin America and Middle East and Africa are expected to be the largest opportunity in terms of revenue of the automotive

repair and maintenance services market. The remaining regions are expected to grow at a steady rate over the forecast period (Leung, 1998).

According to Amoafo (2012), automobile service workshops in Ghana are among the small scale industries that play a pivotal role in the economy. Tetteh (2015) indicates that, figures from the Customs Division of the Ghana Revenue Authority suggest that between 2012 and 2014 over 385,000 vehicles were imported into the country. This means that a good number of service garages are also needed to provide maintenance services to these cars in support of the few dealership garages in the country. The most common automobile repair workshop in Ghana is the local garages where a group of automotive mechanics come together to offer automotive maintenance and repair services. They operate under the informal sector with normally one master owning the shop. The shop is normally built on a piece of land hired from a landlord. A typical local automobile repair workshop has master mechanics that have different specialization in automotive systems. They include automotive electrician, automotive mechanic, welder, brake binder, interior vehicle liner, body sprayer etc (Aniekwu, 2007).

According to Tetteh (2015), in Ghana, a classical local automobile repair workshop has not less than three master mechanics in their specialized areas of automotive electrical, automotive mechanic and brake binder. Each master normally has apprentice trainees who are studying under them. Similar study conducted by Adei, et al. (2011) in Kumasi, the second largest city in Ghana, also indicated that about 54% of sprayers including auto body sprayers, practiced their work in the open air but stored their solvents and equipment in small wooden structures, 13.3% of sprayers practiced in a wooden structure which served as their workshop, and also storage place for their

solvents and equipment. Another group of automobile repair workshops are garages owned by one person but employs automotive mechanics specialized in different areas.

Automobile repair workshops belonging to this category are few in number relative to individual masters owning their garages. They are also engaged in the repair and maintenance of vehicles. Workshops owned by international automobile companies are also opened to the general public for general vehicle repair and maintenance but most people do not patronize their services because of the relatively high fees charged. In Ghana, vehicle owners prefer local automobile workshops for carrying out repair and replacement of parts. This is usually because of proximity and low service charges. Baidoo and Odum-Awuakye (2015) asserted that the SMEs automobile workshop serve as an alternative source of providing after sales vehicle maintenance and servicing to the over 385,000 vehicles imported into the country each year in addition to the number of automobile vehicles already in the country.

2.3 On-Board Diagnostics

The term on board diagnostics refers to the self-diagnosing capabilities that are carried in the computers on the vehicle, and the aids that are provided to make the diagnostic data available to authorized users. The on-board computer systems themselves actually monitor all of the engine emissions controls and systems during vehicle operation. Complicating things a bit is the fact that two generations of on-board computer systems exist-known as OBD-I and OBD-II (Koscher, Czeskis, Roesner, Patel, Kohno, Checkoway & Savage, 2010). As affirmed by Martin (2015) on-board computer systems are designed into vehicles by various automobile manufacturers. This first

generation of On-Board Diagnostics (OBD-I) was developed in the early 1980s and was an attempt by vehicle manufacturers to provide a system that warned a driver/owner whenever there was a malfunction in the emissions control system. The OBD-I systems were designed for use by professional technicians, and each operated uniquely.

In 1988, the California Clean Air Act was signed into law by the governor of the state. This new law set forth all the various rules and regulations for state wide management of air quality for the next 20 years (Koscher et al., 2010). As part of these new regulations, the specifications for standardization of second-generation on-board diagnostics (OBD-II) were implemented. Technology has improved to the point where the reliability of modern OBD-II computers assures functional monitoring of emissions systems every time the engine is started. Given modern OBD-II systems' abilities to detect and store information for subsequent retrieval, myriad problems are simply and easily communicated to each state's emissions' testing program facilitators simply by the act of plugging in a universal OBD-II diagnostic link connector and watching the data stream pour forth (Koscher et al., 2010). These problems range from a loose gas cap to a misfiring spark plug, or disconnected vacuum hose to a bad computer sensor. In addition to easier emissions testing, the second generation of on-board computers provides a much-improved diagnostic tool for both professionals and home technicians alike, by enhancing their abilities to diagnose most engine performance-related problems (Martin, 2015).

2.3.1 OBD I

This required vehicles produced from 1988 onwards to be equipped with electronically (computer) controlled systems that were capable of monitoring themselves.

Any malfunction (defect) that affected exhaust emissions must be displayed on a warning lamp, known as the malfunction indicator lamp (MIL), on the dashboard. The malfunction must be stored in the ECM's memory and it must be readable with the aid of 'on board' facilities, e.g. a flash code on a lamp (Martin, 2015).

2.3.2 OBD II

OBD II strengthens the requirements of OBD I on vehicles of model year 1994and afterwards. OBD II applies to spark-ignition cars and light vans, and from 1996 onwards to diesel-engine vehicles(Martin, 2015). The main features are that the following emissions related systems must be continuously monitored:

- Combustion
- catalytic convertor
- oxygen (lambda) sensors
- secondary air system
- fuel evaporative control system
- exhaust gas recirculation system.

Features of OBD II are as follows.

- The malfunction indicator lamp (MIL) is provided with an additional 'flashing' function.
- The DTCs can be read out by a standard form of scan tool, via a standardized interface that uses a 16-pin diagnostic connector
- The emissions-related components must be monitored for adherence to emissions limits in addition to monitoring them for defects.

- Operating conditions (performance data) can be logged and stored in a 'freeze frame'.

2.4 Types of Off-board Diagnostics Equipment

According to Charette (2009), off-board diagnostic is equipment such as oscilloscope, scan tool, diagnostic code readers, data link connector (DLC), computer diagnostic testers, exhaust gas analyzers, computers, internet connectivity, and other test equipment. In most cases both types of equipment are required for vehicle repair work.

2.4.1 Flat screen oscilloscopes

Oscilloscopes of the cathode ray type have long been part of the equipment for workshop-based diagnostic work. Recent developments in liquid crystal displays (LCDs) and thin film transistor (TFT) technology have made small portable oscilloscopes possible and they are available from several suppliers at reasonable cost. According to Charette (2009) flat screen oscilloscopes have considerable value because they are versatile and can measure sensor and other components' performance very accurately.

2.4.2 Scan tool

The electrification of automotive components is increasing rapidly as the consumers' preference is shifting from manual functions to sophisticated automated systems (Charette, 2009). Such technological changes are increasingly demanding for tools which can detect the problem or the malfunctioning of electronic system used in cars with ease. Automotive diagnostic scan tool are set of electronic devices and software

which are used to interface with diagnose systems. Automotive diagnostic tools are also used to reprogram and upgrade the vehicle control modules. Nowadays, a number of companies are engaged in manufacturing of diagnostic scan tools with multifunctional capabilities which can read from simple codes to highly complex codes while performing power train, chassis and body diagnostics. Automotive diagnostic scan tools are widely used in vehicle service station for all types of vehicles ranging from passenger vehicle car to heavy commercial vehicle to agriculture vehicles. According to the study by Miller and Valasek (2013), a scan tool can often point the technician in the right direction, perhaps indicating a misfire on a specific cylinder but too often the less experienced technician then ends replacing several parts before the problem is solved. Scan tools are used:

- To eliminate guesswork and test individual components before they are replaced. This avoids "parts darts" where more and more parts are replaced until the fault goes away.
- To find intermittent wiring and connector faults.
- When a vehicle has a problem but no code has been set or when multiple / misleading codes have been set
- As the best way to find charging and starting problems.
- To find problems with actuators such as motors and injectors that are not monitored by the ECU.
- To identify mechanical problems such as compression and slipped / incorrectly fitted timing belts.

As affirmed by Miller and Valasek (2013), for the technician, oscilloscopes lead to faster, more efficient diagnostics and a better understanding of how vehicle systems

work. For the workshop using a scan tool encourages a "fix it right" culture by reducing the number of parts changed on guesswork. The net result is improved customer satisfaction, increased repeat business and increased profits.

2.4.3 Computer diagnostic testers

According to Charette (2009), automobiles use sophisticated technology to operate correctly and are mainly controlled by computers. The performance of automobile is determined in a large way by this sophisticated technology. Whenever automobile is not running right or the unpopular check engine light is illuminated, computer diagnostics testers can determine which component is malfunctioning. Auto Computer Diagnostics performed can help whenever a mechanic is experiencing automobile problems. Ward, Ibarra and Ruddle (2013), asserted that computer diagnostic testing identify any internal problems.

According to Robbins and Judge (2007), the onboard computer system in automobile gives information that it has determined that service is required because it has detected a problem with at least one of the several different systems that it controls and/or monitors, such as transmission or engine whenever a warning light is illuminated. Therefore, computer diagnostic testing is recommended to provide with an accurate assessment of the condition of automobile.

2.4.4 Diagnostic code readers

Code readers are the most basic computer diagnostic tools that find and provide a pretty basic way of interacting with car's onboard computer. The most basic diagnostic

tool is a code reader. A code reader can access and display codes from vehicle's computer. The least expensive models only display a number while the better ones also provide a definition (some are even multilingual and can display in English, Spanish or French) (Abdulsomad, 2000).

A code reader can also clear codes to turn off the Check Engine light. Some code readers can also display the "ready" status of various OBD II monitors (ready means the monitor has completed its self-check process). But a code reader is NOT a scan tool because it only reads and clears codes. It does NOT display any sensor data or other system operating information. To read sensor and other system data, you need some type of scan tool or scanner software. Most diagnostic code readers only scan and display the problem diagnostic codes. To diagnose car problems without going to a mechanic with an auto code reader, simply plug it into the car's computer system, then interpret the trouble code readout. According to Miller and Valasek (2015), no two code readers are exactly alike, and feature sets can differ from one model to another. In general, there are some things every code reader can do.

Things a code reader can do.

- Read and display codes.
- Clear codes and reset the check engine light.

Things a code reader maybe able to do:

- Display trouble code names.
- Read and display live data.
- Display freeze frame data.
- Display readiness monitor status.

- Reset readiness monitors.

Things code reader cannot do:

- Provide troubleshooting information or tips.
- Record and play back live data.
- Graph data or graph specific PIDs.
- Read manufacturer or pending codes.
- Utilize functions that require bi-directional communication (Miller & Valasek, 2015).

2.4.5 Data link connector (DLC)

According to Miller and Valasek (2015), The data link connector (DLC) is the multi-pin diagnostic connection port for automobiles, trucks, and motorcycles used to interface a scan with the control modules of a given vehicle and access on-board diagnostic and live data streams. Prior to 1996, many OBD-I data link connector's were in the engine compartment, usually near the fuse block. Also, prior to 1996, there was no standardization for these connectors, and each manufacturer had its own shape with a unique pin arrangement. After 1996, many manufacturers retained their proprietary connectors in addition to the OBD-II interface, because OBD-II ports are only required to transmit emission related codes and data (Ribbens, 1998).

2.5 Challenges faced by wayside Garages in the advent of Automobile Technology

Rapid development of automobile technology has presented some challenging problems for wayside garages in the country. Ribbens (1998) noted that the use of scan tools like On-Board Diagnostic One, Two and Three (OBDI, OBDII, and OBDIII) have common place in the repair of automobiles in the manufacturer's approved service centres today. OBD systems give the vehicle repairer access to the status of the various vehicle sub-systems and give the mechanic a clue as to where to look at when a problem occurs on the vehicle. But for one to be able to use this tool the mechanic must be able to understand the principles behind its usage.

Okuta and Dawha (2014) examined the concept of entrepreneurship development, the roles of government and non-governmental organizations, which revealed that the challenges are caused by inadequate funding in the adoption of technology. In Ghana, Edunyah (2015) identified changes in modern vehicle technologies, their challenges associated with repairs and possible opportunities available to wayside garages using survey research method as the data collection tool. The study showed that the major challenges facing wayside garages in the advent of technology is the lack of skills on the use of the on-board diagnostic scan tool.

The US Department of Labour statistics (2012) estimated that due to the increasing average lifespan of cars and growth in the number of cars being driven, the department projected the demand for automotive mechanics to increase by 9% between 2012 and 2022. Those with specialized knowledge or training will have the best opportunities. The rate of change in technology is exponentially increasing. Nations,

industries, and individuals must develop their capabilities to keep abreast with technological changes and to harness technology. A number of development and long standing issues have combined to endanger wayside mechanics' development in automobile technology in Ghana. Some of these key challenges include: Technology dependence, deplorable state of training institutions, lack of dynamic curriculum, negative attitude, shortage of qualified personnel in automobile technology education, inadequate funding of technical education institutions and perceived complexity of a technology.

2.5.1 Technology Dependence

Total dependence on imported technology has been one of the major challenges faced by entrepreneurial development. Dawodu (2001) lamented that the low patronage of indigenous and locally made products and the low productivity of manpower is due to over reliance on imported knowledge which in its real sense does not give room for entrepreneurial development. Most important, is the issue of marketability of locally made products after going through the entire process since most of such products are imported and readily available in the market.

2.5.2 Deplorable State of Training Institutions

Institutions that are saddled with the responsibility of training manpower are faced with some major problems resulting from the quality of entrants, low level funding inadequate funding and training facilities as well as dearth of staff. These factors create setbacks in entrepreneurial development. More worrisome is the quality of students who

gain entrance into technical training institutions most of which are without adequate requisite qualification grossly hampered the process (Jibodu & Ude, 1996).

2.5.3 Lack of Dynamic Curriculum

According to Jibodu and Ude (1996), curriculum is a major material for carrying out training in institutions. Jibodu and Ude further stated that curriculum must be updated or reviewed in other to update knowledge and skills to match development in science and technology. Gaius (2001) opined that there is the need for the curriculum of technical institutions to be reviewed in favour of skill practical acquisition. The practical lesson needs more allocation and time, lack of curriculum review hampers keeping abreast with current issues of fast developing technology.

2.5.4 Negative Attitude

Public attitude towards technical education and automobile technology in particular affects in producing competent students in the automotive service industry. Technical education is seen as a profession for drop out, for those who are unable to cope up academically in schools. It is also considered that graduate in automobile technology end up as wayside mechanics or as classroom teachers which according to them holds no better future (Jibodu & Ude, 1996). This is not true and very unfortunate for a country like Ghana which hopes to breed entrepreneurs and subsequently be self-reliant. However, a society with such notion about technical education will hardly accord any merit to the profession not to talk of giving a word of encouragement to those interested in the profession.

2.5.5 Shortage of Qualified Personnel in Automobile Technology Education

Most of the training institutions lack qualified manpower that will impact the skills needed for entrepreneurship development. Olalekan (2001) lamented that technical institutions do not have enough manpower to handle the machines, service and maintain them well. This factor hampers the acquisition of skill that can help in developing entrepreneurial development in Automobile Technology.

2.5.6 Inadequate Funding of Technical Education Institutions

Gana and Bodams (2004) lamented that while successive governments at all levels have given priority to the establishment of science and technology institutions, the quality and quantity of technical students in universities has been constantly deteriorating. Improper funding of such institutions has seriously hampered the quality of graduates they produced.

2.5.7 Perceived Complexity of a Technology

The complexity (ease to use or learn) of a technology have impact on adoption. If the use of a new technology requires considerable learning it is less likely to appeal to users. In addition the perceived complexity of a technology lead to increased uncertainty and perceived risk, and these in turn could lead to a resistance to adopt (Jolly, 2011). A study was conducted by Rahim, Ladipo and Kunle (2013) titled "Perceived attributes of successful and unsuccessful Innovations". The general objective of the study was to assess the perceived attributes of successful and unsuccessful innovations. The study used both descriptive and explanatory research design, using secondary information. It

described the study variables and at the same time provided explanation on why certain innovations diffuse faster and why others fail. Findings of the study indicated that ease to use (complexity), relative advantage, compatibility and observability and in that order are the main factors that determine the rate of technology adoption.

2.6 Theoretical Framework

The decision of whether an individual will adopt a particular technology and the time frame involved with that decision has been a long source of research across multiple disciplines, and it influences business, schools, and everyday life. However, the concept of technology literacy is increasingly becoming integrated into mandated curricula (Shield, 2013). Adoption theory examines the individual and the choices an individual makes to accept or reject a particular innovation. In some models, adoption is not only the choice to accept an innovation but also the extent to which that innovation is integrated into the appropriate context. Adoption theory, then, is a micro perspective on change, focusing not on the whole but rather the pieces that make up the whole while diffusion theory takes a macro perspective on the spread of an innovation across time. In contrast, diffusion theory describes how an innovation spreads through a population (Anderson & Harris, 2010; Wicklein, 2012, Pucel, 2008 and Pucel, 2014).

Another study conducted by Owston (2013); “Contextual factors that sustain innovative pedagogical practice using technology” revealed that ease to use or perceived complexity play a major role in technology adoption. The study applied a logistic regression model with a general objective of determining contextual factors that lead to sustainability of innovations. The study concluded that serviceability of an innovation is

positively related to its sustainability. This is corroborated by Ngure (2013) who argues that due to the increasingly labyrinthine nature of the technology that is now incorporated into automobiles, most automobile dealerships and independent workshops nowadays provide sophisticated diagnostic computers to technicians, without which they would be unable to diagnose or repair modern vehicles.

In addition, Tan and Leo (2012) conducted a study to establish factors influencing the adoption of new technology. The cross sectional survey sent out a questionnaire to 346 employees sampled from institutions in Malaysia. Appling a multiple linear regression model, the study unveiled that among other factors, relative advantage, compatibility and complexity influenced adoption. Identifying and closing skills deficiencies is vital to long-term economic prospects in order to sustain sectors like the informal motor vehicle mechanics that are at risk of disappearing, not being developed or leaving their main tasks to be taken up by formal dealership garages. Experience has shown that lack of skills is the principal factor related to poor quality and productivity and that attitude is often the constraint to turning ideas into products and a successful business (Morgan, 2014). Complexity attribute is related to benefit costs in the innovation for the adopters. Individuals or organizations would likely adopt the innovation if it is easy to understand (Rogers, 2003).

2.6.1 Theories of Technology Diffusion and Adoption

Innovation typically involves broad aspects of curriculum and instruction and might encompass a wide range of technologies and practices. One theory dichotomy relates to the scale of innovation efforts by distinguishing between macro-level theories

and micro-level theories. Macro-level theories focus on the institution and systemic change initiatives. Micro-level theories, on the other hand, focus on the individual adopters and a specific innovation or product rather than on large-scale change.

The decision of informal automobile mechanics to adopt modern technology is a complex process with a wide number of influencing factors. A key issue in trying to determine future adoption of a technology is to understand why an individual would adopt one technology while resisting another. According to Straub (2009), "*technology adoption is (a) a complex, inherently social, developmental process; (b) individuals construct unique (but malleable) perceptions of technology that influence the adoption process; and (c) successfully facilitating a technology adoption needs to address cognitive, emotional, and contextual concerns"*. A number of models and theories have arisen which aim to uncover the factors that will influence the adoption of technology. These factors range from focus on the technology itself through to the psychological characteristics of the individual (Dillon & Morris, 1996). Due to the wide ranging issues of why an individual would accept or reject a technology, it is unlikely that a single-variable explanation could account for this decision. Theories have been developed to help understand adoption and have been used to explain adoption in the educational context.

2.6.2 Technology Acceptance Model

Technology Acceptance Model, developed by Davis (1989), is one of the most influential research models in studies of the determinants of technology acceptance to predict intention to use and acceptance of technology by individuals. Technology

Acceptance Model has received considerable attention of researchers in the information system field over the past decade. In the Technology Acceptance Model, there are two determinants including perceived ease of use and perceived usefulness. Perceived usefulness is the degree to which an individual believes that using a particular technology would enhance his or her job or life performance. Perceived ease of use is the degree to which a person believes that using a particular technology would be free of effort. Perceived ease of use and perceived usefulness positively affect the attitudes toward an innovation; and further, positively affect the individuals‟ intentions to use and the acceptance of a technology. In addition, perceived ease of use positively affects the perceived usefulness, and both perceived ease of use and perceived usefulness are influenced by external variable. Up to date, many researchers added new variables based on the Technology Acceptance Model.

Jing, Xuefeng, Donghua and Xiao (2015) added the construct of compatibility in the Technology Acceptance Model. Dishaw and Strong (1999) integrated Technology Acceptance Model with Task-technology Fit. Lewis and Gagela (2012) added cognitive absorption, playfulness and self-efficacy based on Technology Acceptance Model. Venkatesh and Davis (2000) added subjective norms with Technology Acceptance Model. LaPorte and Sanders (2013) integrated peer Influence with Technology Acceptance Model. Juneseuk and Hakyeon (2013) added personal innovativeness with Technology Acceptance Model. Shield (2013) and Iztok and Krsto (2014) added the construct named trust with Technology Acceptance Model.

Pucel (2008) and Johnson (2009) integrated technology readiness with Technology Acceptance Model. Chen et al. (2009) synthesized the essence of technology

readiness, Technology Acceptance Model, and Theory of Planned Behavior to propose an integrated model for understanding customers‟ continued use of self-service technologies. Lee (2009) united the Technology Acceptance Model with Theory of Planned Behavior, perceived risk and perceived benefit to understand the adoption of internet. Chen and Chen (2009) re-examined the Technology Acceptance Model to understand the automotive telematics users‟ usage intention. Stern et al. (2008) proposed a revised Technology Acceptance Model to investigate the consumers‟ acceptance of online auctions. Serenko et al. (2007) modified Technology Acceptance Model to assess user acceptance of interface agents in daily work applications. Chen et al. (2009) proposed an integrated model including Technology Acceptance Model, Theory of Planned Behavior, and Technology Readiness to explain the users‟ adoption of self-service technologies.

A number of theories have been advanced by Rogers (1962, 1995, & 2003) and they include: a) Innovation decision process theory which asserts that, potential adopters of a technology progress over time through five stages in the diffusion process, b) Individual innovativeness theory which argues that, individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion, c) Rate of adoption theory, asserting that diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual stabilization and finally a decline and d) the perceived attributes theory.

2.6.3 The Innovation Decision Process Theory

The innovation decision process theory is one the many theories advanced by Rogers (1995) which asserts that Potential adopters of a technology progress over time through five stages in the diffusion process. First, they must learn about the innovation (knowledge); second, they must be persuaded of the value of the innovation (persuasion); they then must decide to adopt it (decision); the innovation must then be implemented (implementation); and finally, the decision must be reaffirmed or rejected (confirmation).

2.6.4 The Perceived Attributes Theory

In order to enhance communication and promotion effectiveness towards a targeted audience and besides understanding of the adopters‟ characteristics, there are three factors that influence innovation adoption decision: innovation attitudes in a community, external network effect, and population characteristics through which diffusion is to occur. Rogers (2003) identified five attributes of innovation that influence the diffusion process. Four of these attributes: relative advantage, compatibility, complexity and observability are hypothesized in this study as having a key influence to the adoption of technology within the informal automobile mechanics.

An innovation is considered for adoption if: it has an advantage over other innovations or the present circumstance (relative advantage). The relative advantage of one technology over another is a key determinant of the adoption of new technology. It is the level of innovation perceived as better than a previous idea. The issue of relative advantage has been shown to have a positive relationship with adoption of innovation (Tornatzky & Klein, 2011; Anderson & Harris, 2010; Grover & Güttler, 2013). Users

need to be shown that modern automobile technology offers considerable benefit compared to traditional offering. A number of researchers have highlighted some of the key benefits that modern motor vehicles offer. Taking the Electronic Fuel Injection (EFI) system as an example, some of these advantages include: (i) Uniform air/fuel mixture distribution. Each cylinder has its own injector which delivers fuel directly through the intake valve. This eliminates the need for fuel to travel through the intake manifold, improving cylinder to cylinder distribution. (ii) Highly accurate air/fuel ratio control throughout all engine operating conditions. EFI supplies a continuously accurate air/fuel ratio to the engine no matter what operating conditions are encountered. This provides better driveability, fuel economy, and emissions control. (iii) Superior throttle response and power. By delivering fuel directly at the back of the intake valve, the intake manifold design can be optimized to improve air velocity at the intake valve. This improves torque and throttle response. (iv) Improved emissions control. Cold engine and wide open throttle enrichment can be reduced with an EFI engine because fuel "flooding" in the intake manifold is not a problem. This results in better overall fuel economy and improved emissions control. (v) Improved cold engine start ability and operation. The combination of better fuel atomization and injection directly at the intake valve improves ability to start and run a cold engine. (vi) Simpler mechanics, reduced adjustment sensitivity. The EFI system does not rely on any major adjustments for cold enrichment or fuel metering. Because the system is mechanically simple, maintenance requirements are reduced (Innova, 2011; Growse, 2012 & Hayden, 2009).

An innovation is considered for adoption if it fits in or is compatible with the circumstances into which it will be adopted (compatibility).This is the degree an

innovation is perceived to be consistent with existing values or previous experience and need to the potential adopter. If the adopters require adjusting their existing routine and or the innovation or invention is in contrast to their attitudes, the more unlikely they are to adopt it (Appleton, 2012). In addition the user's previous experience of adoption of new tools, whether this was a positive or negative experience will also influence the adoption of technology. A negative previous experience can result in innovation negativism which is where a negative previous experience with one innovation can negatively impact the adoption of another. In the case of automobiles, the diagnosis, service or repair of electronic fuel injection and automatic transmission systems is quite different from the traditional carburetor and manual gearbox systems. In the case of auto-body mechanics' tasks; the introduction and use of fiber glass, aluminum, and hard plastics as auto-body panels has necessitated the development of newer paints like spike hecker, metallics and sadocrylls. The repair of these panels may require complete replacement or advanced welding equipment like the tig and mig welders unlike the conventional arc and oxy-acetylene welders used in the traditional mild steel panels. It is inevitable for auto-body mechanics to adopt these innovations if they are to remain competitive in the industry (Growse, 2012).

An innovation is considered for adoption if it is not overly complex to learn or use (complexity). Complexity (ease of use or learning) of a technology will also impact on adoption. Perceived complexity of the technology can lead to increased uncertainty and perceived risk, and these in turn could lead to a resistance to adopt (Childress, 2011). According to Betts, Welsh and Ryerson (2011), to explore the complexity of an innovation, it is necessary to understand the contexts in which it occurs. Nowadays,

automobile makers incorporate electronic systems to control vehicle functions. This development has dramatically increased the complexity of the systems found in automobiles (Edmunds, 2011). These complex systems have vastly improved vehicle performance, safety and fuel efficiency, but also increased the likelihood of breakdowns. The more interdependent parts a system has, the higher the probability that the system will fail, after all. However, the on-board computer has made troubleshooting much easier when something does go wrong.

During the1980s, a universal system was established by the Society of Automotive Engineers (SAE) known as the On-Board Diagnostic system (OBD-II). This system became mandatory in 1996. When something goes wrong in a vehicle fitted with an OBD-II system, a "Check Engine" light flashes on the dashboard. A mechanic can plug into the vehicle computer and retrieve a code. This code is then cross-referenced with a handbook of codes and their meanings (service manual), leading the mechanic to an accurate diagnosis of the vehicle's problem. Using OBD-II diagnostic tools, repairs are reliable since trial-and-error is eliminated. On the other hand, when something does go wrong, the cost of repairing modern vehicles can be more expensive than it was to fix an older models a few decades ago. The more complex modern engines require competent computer literate mechanics to repair. Because of the increased difficulty in managing the number of parts that would require replacement in the event of a crash, the cost of modern cars is more expensive (Growse, 2012). Other innovations pose unique complications to informal mechanics. For instance most automatic transmission problems can't be fixed by an average mechanic. There are just too many specialized tools and pieces of equipment one will need before attempting any repair. Airbag Systems in

modern vehicles are highly complex systems with a number of components that require exact replacement and testing procedures, which require expensive equipment to test, examine, analyze, and repair. In most cases, the repair involves replacement of components. Most of the crash sensors are 'one-time-use' components, and are replaced, as they are not repairable (Lemurzone, 2012).

An innovation is considered for adoption if its results can be seen or observed (observability). Observability is where by an innovation use and effects must be visible by others. According to the Society of Automobile Engineers (SAE), all vehicles manufactured after the year 1996 must be OBD II compliant (Innova Electronics, 2012). And with the government of Kenya policy that all vehicles imported into the country must be less than 8 years old since manufacture, it then means that most vehicles in the country incorporate EFI systems. In the case of gear shifting mechanisms, 85% of automobiles manufactured globally use automatic or semi-automatic transmission systems; commonly known in Kenya as “automatic gearbox” (Growse, 2012). For this reason, a large number of automobiles in Kenya, including heavy commercial vehicles use automatic transmission systems.

In this regard, the wayside garages have no choice but to adopt these technologies if they are to remain in business. Overall, for a technology to be adopted, it needs to show relative advantage, compatibility and lack of complexity. In addition users, especially mechanics need to see a technology in action and be given a chance to try out this technology themselves. The innovation or invention itself is important to consider, however, as shown in the last two characteristics, the perception of the user is also important.

2.7 Conceptual Framework

The Gaps Model is a conceptual model, especially developed to qualitatively measure service quality. It was developed by Parasuraman et al. in 1985 based on results from empirical research. The Gaps Model identifies five organisational gaps within the process of service design and delivery that cause deficits in quality, leading to unsatisfied customers (Parasuraman et al., 1985). As illustrated in Figure 2.1, the Gaps Model locates and maps five generic gaps that applyregardless of the type of service.

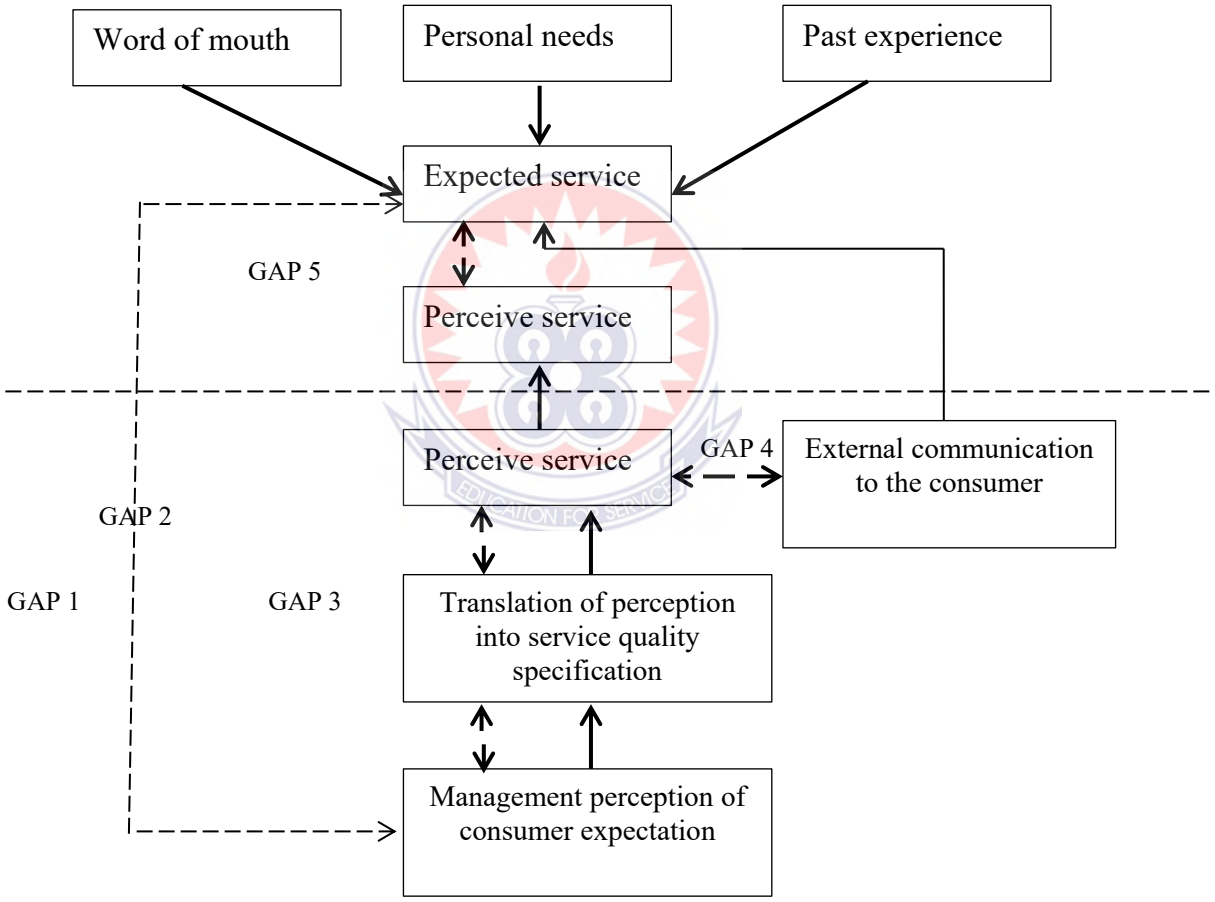

Figure 2.1: Conceptual Framework on quality services
Source: Parasuraman et al (1985) Five Gap Model of Service Quality

Gap 1 indicates the difference between the customer's actual expectations and that of management, Gap 2 indicates the difference between management perceptions of customer expectations and the firm's stated service standard. Again Gap 3 looks at the

difference between the service delivered and the requirements stated in the firms‟ service standards. This gap occurs when the firm is not able to meet the service quality as set out in their standards.

In Gap 4, the difference between the firm's stated service standard and the firm's external communication is indicated. Gap 5 is the difference between the expectations of the customer regarding the service delivered and the actual service experience. The key to ensuring good customer service is being able to meet or exceed the expectations of the customer. Parasuraman et al. (1985) argued that perceived service quality is the degree and direction of discrepancy between Customers" perceived expectations. Brown and Bond (1995) indicate that the GAP model is one of the best received and most heuristically valuable contribution service literatures. The first four gaps are identified as functions of the way in which service is delivered, whereas GAP 5 pertains to the customer and as such is considered to be the true measure of service quality (Parasuraman et al., 1985). The GAP 5 is the GAP that SERVQUAL instrument influences.

CHAPTER THREE

METHODOLOGY

This chapter presents the methodology of the study. It discusses the study area, research design, population of the study, sampling and sampling technique employed, data collection instrument and data collection procedure used. It also discusses validity and reliability and data analysis technique relating to quantitative studies.

3.1 Study Area

Accra metropolitan area is simultaneously a city and metropolitan district that contains the historic centre and central business district of Accra Metropolis. Since its establishment in 1898, Accra has served as the capital of the Greater Accra Region and the Accra Metropolitan District, with which it is coterminous. The district constituted Accra until the enactment of Legislative Instruments 1865 and 2038, which carved out the Ledzokuku-Krowor and La-Dade-Kotopon municipal districts from the Accra Metropolitan District. The district's new boundaries cover a total land area of 139.674 km^2. The population of Accra Metropolitan Assembly (AMA), according to the 2010 Population and Housing Census, is 1,665,086 representing 42 percent of the region's total population. Males constitute 48.1 percent and females represent 51.9 percent.

The metropolis is entirely urban (100%). It has a sex ratio of 93.0% and youthful population (children under 15 years) (42.6%) depicting a broad base population pyramid which tapers off with a small number of elderly persons (60+ years) constituting 5.9%. The employment with regards to the population 15 years and older, 48 percent are self-employed without employees, 2.2 percent are contributing family workers, 2.0 percent

are casual workers and 0.9 percent are domestic employees (house helps). The private informal sector is the largest employer in the metropolis, employing 74.0 percent of the population followed by the private Formal sector with 16.9 percent.

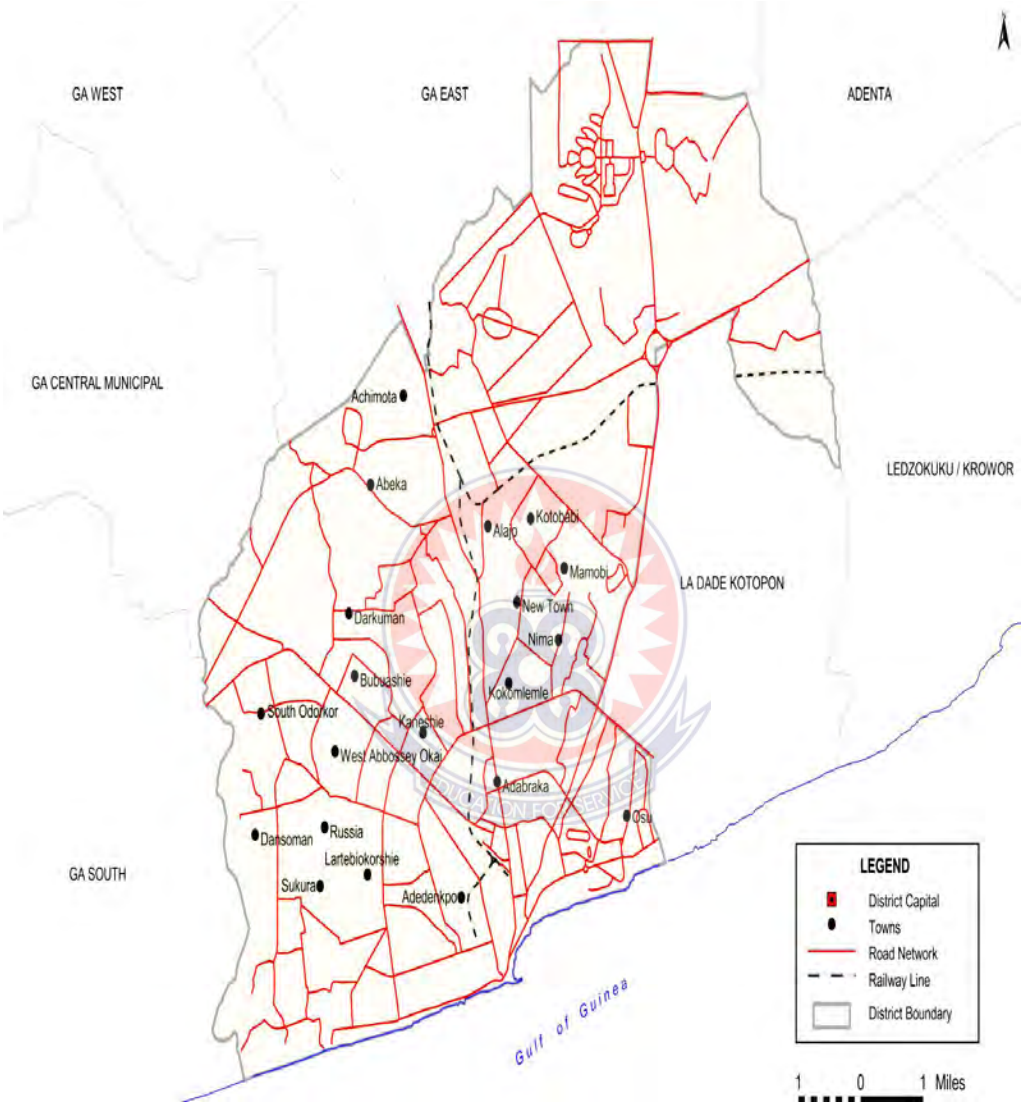

Figure 3.1: Map of Accra Metropolis

Source: Ghana Statistical Service (2010).

3.2 Research Design

To be able to gather the necessary data, the survey method was used. Survey research design is a type of descriptive research where the research administers a questionnaire to a sample or to the entire population to describe the attitudes, opinions, behaviours, or characteristics of the population (Creswell, 2012). Creswell asserts that in this procedure, survey researchers collect quantitative, numbered data using questionnaires (e.g., mailed questionnaires) and statistically analyze the data to describe trends about responses to questions and to test research questions

The survey research design was used because of it being fact finding in nature. This help the researcher to analyze and interpret the current state of the people involved in the study, provide an analyses and help in the interpretation of data for the guidance of the future course of action. Kothari (2004), posits that the survey research design is where a sample of the population is studied (questioned or observed) to determine its characteristics or relationship, and it is then inferred that the population has the same characteristics or relationship.

3.3 Population of the Study

The population for the survey involved in this study consisted of an estimate of 350 wayside garages observed by the researcher in Accra Metropolis. The choice of Accra was prompted by the fact that it has a huge transportation and tourism potential. Road transport is the main mode of transportation as witnessed by a large number of vehicles in the town lately and an increasing number of automobile franchises and wayside garages all positioning themselves to get a market share in terms of service

provision given the potential demand. Another reason is that, in Accra Metropolis, more than 95% of the wayside garages are concentrated in one central point; the industrial area. This makes it convenient to access the target population within a short period.

3.4 Sample and Sampling Technique

Sample size is a small group of people chosen from the targeted population. Getting a sample in a research is very important. This is because all members of the study area cannot be studied (Moss, 1994). A non-probabilistic sampling method was utilized based on the design of the research and participant selection; probabilistic sample methods were not feasible for the study since the sample was deliberately selected and not chosen by chance or a random act. The procedure used in this study to select participants was the utilization of the purposive sampling technique.

The units of observation were the 350 owners of roadside garages operating in the Accra Metropolis. The appropriate sample size was extracted from the Krejcie and Morgan (1970) table, established as reliable in determining the sample size needed to be a representative of a given population. Based on this table the sample size determined was 186 (refer to Appendix A). In arriving at the sample for the study, purposive sampling technique was employed to select 186 owners of roadside garage. The main goal for purposive sampling was to focus on particular characteristics of a population that are of interest, which will best answer the research questions.

3.5 Data Collection Instruments

In order to achieve the aim and objectives of the study, well-structured close-ended questions were designed to gather information from roadside garage owners. Close-ended questions were used because of the fact that they are easy for respondents to answer and they are also easy for researchers to analyse data (Gay, 1996). The data from the respondents was collected using, mainly; structured multiple choice questions employing a five-point Likert Scale.

The questionnaire contained two sections: The first section sought background information of the roadside garage owners while the second section addressed technical questions related to the three objectives of the study. Respondents were expected to tick (√) the created boxes of columns where they strongly agree; agree; disagree and strongly disagree to the given statements. In this study, the Likert scale which had five columns from number five to one in a requisite order attached to various columns. On the scale, the rating was arranged in five columns. The Likert scale provides the basis for neutral response, as well as ranking highest and lowest responses of respondents in the study. Here, the weight attached ranges from five to one with responses coded 1-5. Responses were ticked (√) in the available boxes with correspondents boxes attached. The Likert scale indicated the following: Strongly Agree (SA) - (5); Agree (A)-(4); Neutral (N) – (3); Strongly Disagree (SD) – (1); and Disagree (D) - (2). The strongly agree (SA) exhibits the most powerful weight of five to the issue of discussion.

According to Stockburger (2007) responses to several five point Likert questions may be summed, providing that all questions use the same Likert scale. He further added that Likert scale data can, in principle, be used as a basis for obtaining interval level

estimates on a continuum. Rating scales consist of numbers and descriptions which are used to rate or rank the subjective and intangible components in a research (Mugenda, 1999). The numerical scale helps to minimize the subjectivity and make it possible to use quantitative analyses.

3.6 Data Collection Procedures

The data was obtained from two main sources: primary sources which included direct interaction, observation and responses from a self-administered questionnaire; and secondary sources, mainly, from formal garages and available records at the enterprise level. Review of such works was useful in cross-checking and authenticating the primary data. Both open-ended and closed-ended questions were used to capture both general and specific information given by the respondents in order to address the specific objectives.

The researcher obtained permission from the owners of wayside garages in Accra Metropolis before administering both questionnaires. The questionnaires were personally administered by the researcher to 186 owners of wayside garages. The questions were explained to respondents to further establish better rapport. The researcher gave the garage owners few days to respond to the statements, and later collect all the questionnaires for further analysis.

3.7 Validity and Reliability of the Instrument

Validity and reliability are important aspects of any research. Because of the difference between them, validity and reliability can be addressed in different ways. Their importance was discussed with respect to quantitative data in this section.

3.7.1 Validity

In any research, 'validity' is an important concept to keep in mind. If a research has low validity, it is worthless (Cohen, et al., 2005). Validity is defined, according to Shukla (2008), as "the extent to which differences in observed scale scores reflect the true differences among objects on the characteristics being measured." For Cohen *et al.* (2005) and Best and Kahn (2005), validity presupposes that an instrument measures what it is supposed to measure. In other words, validity helps the researcher to decide on the scale, measuring what it is meant to measure. The concepts that are included in the instrument help to achieve content validity (Muijs, 2004). Getting comments and judgment from colleagues is another way of looking for validity, namely, face validity. Cohen *et al.* (2005) contend that validity in quantitative research might be ensured through different means, such as sampling, appropriate instrumentation and appropriate statistical treatment of the data. In addition, validity was checked by reviewing the data collection instruments in terms of clarity, wording and sequence of questions.

In order to assess the validity of the revised instrument, different analyses have been performed by the authors (Parasuraman *et al.* 1991). They examine the validity of the instrument by analyzing the difference between the instrument gap scores and customers rating on several measures of service quality by using a ten point Likert scale.

The face validity was also checked and the responses of the participants in that study confirms that instrument with minor modifications in terms of a few items had face validity (Parasuraman, et al., 1991). Babakus and Boller (1992) also support its suitability. In this research, content validity of the instrument was demonstrated by fair and comprehensive coverage of the items that it is supposed to cover.

3.7.2 Reliability

Reliability is another important element that determines the quality of the instruments and the measured results (Muijs, 2004). Best and Kahn (2005) define reliability as "the extent that the instrument measures whatever it is measuring consistently." For O'Lary (2004), reliability refers to "... the extent to which a measure, procedure or instrument provides the same results on repeated trials." This shows that reliability is concerned with the precision and accuracy of the instruments and measures when used repeatedly. Reliability, therefore, is not dependent on who, at what time or where the questionnaire was administered (O'Lary, 2004; Bailey, 2007). The reliability of the instrument for the present study was checked using the internal consistency method (Cronbach's alpha coefficients).

In different empirical studies, the reliability of the instrument was examined using the Cronbach's alpha coefficients. For example, in their study, Fernandez and Bedia (2005) identify the values of 0.894 and 0.903 respectively. The values (regarding both perceptions and expectations) are close to one, which indicates that the instrument has a high level of internal consistency. Zafiropoulos and Vrana(2008)confirm that the instrument was found to be a concise multiple-item scale that was reliable in several contexts. All the dimensions of the scale for this study were found to be reliable. In general, according to the pilot and main study results, the instrument scale was found valid and reliable.

3.8 Data Analysis and Presentation

After collection, the data was first organized. The agreement scale was simplified by combining the four response categories into two nominal categories: disagree and agree, thus, the possibility of parametric analyses. The data was then coded before entry into the computer for analysis. The statistical software: Statistical Package for Social Sciences (SPSS) version 20.0 was used for preliminary analyses which involved production of frequency distributions and cross tabulations of the variables.

3.9 Ethical Review Process

Research ethics, as postulated by Van de Sande and Schwartz (2011), is a process of protecting the interest of research participants. The research study did not cause harm to the research participants. Risk was minimized to participants by ensuring informed consent, confidentiality being upheld and accurately reported the results of my study. Ethics embraced principles which were rules or guidelines followed by the researcher and ensured that the interests of human participants were protected (Van de Sande & Schwartz, 2011). Ethics as a moral practice is used to ascertain a set of values around what is right and wrong. Issues around ethics signify concerns, dilemma and conflict that surface about the proper manner of conducting research (Van de Sande & Schwartz, 2011). While conducting the research, the researcher adhered to the following responsibilities:

3.9.1 Institutional approval

The institution where the research originates provided permission to the researcher to conduct social research. Previously, in the 20th century, researchers were directly involved in the ethical issues of the survey research. They conducted survey research on vulnerable participants, such as, minors without the parents' consent. However, this was rectified in the 1960s, where it was established that some scientists conducted research unethically (Ellis, Hartley & Walsh, 2010).

3.9.2 Respect to human dignity

The researcher viewed the aspects of protecting the multiple and interdependent interests of the participants from psychological harm and to respect cultural integrity, as important (Van de Sande & Schwartz, 2011). This notion is also supported by Hofstee (2006:135) when emphasizing that the questions asked should be neutral and not intimidate or offend the interviewee.

3.9.3 Informed consent

Where social science is predominant, informed consent is a legal requirement (Ellis et al., 2010). Informed consent entails informing the potential participants about the basic purpose of the study and obtains permission from them to be involved, with the mutual understanding that they are free to withdraw from the study any time they feel unresponsive. In this study, the researcher dispensed explicit informed consent forms to the participants. The participants signed the written form that outlined the detail nature of the study (Ellis et al., 2010). However, the detailed nature of the information the

participants are shared with, is minimal enough not to jeopardize the validity of the researcher's findings. The notion of the informed consent insinuated that the participants in the study are not compelled to partake (Ellis et al., 2010).

3.9.4 Confidentiality

Before answering the questionnaire, the researcher pledged to research participants that their identity would not be revealed as the source of information when the findings were reported. This also equally applied to anonymity (Ellis et al., 2010). As data were obtained confidentially, it was the duty of the researcher to uphold the confidentiality of data. Original data access was restricted to those the researcher trusted (Neuman, 1997).

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter deals with results and discussion. The chapter is presented under the following headings: Background of respondents; knowledge level of the wayside mechanics on diagnostic equipment in the maintenance services; reasons car owners send their cars to wayside garages at the expense of diagnostic equipment; challenges faced by wayside mechanics in the advent of automobile technology; and the effect of diagnostic equipment on the maintenance services of wayside garages in Accra Metropolis.

4.1 Response Rate

A total of 186 questionnaires were sent out to collect data from respondents. However, after the data collection exercise, it was realised that 118 out of the 186 questionnaires sent out were good to be included in the analysis. Whilst some of the questionnaires were not returned, key questionnaires that were critical in meeting the study objectives were not answered on some of the returned questionnaires. The response rate achieved was therefore 63.4%. According to Mugenda and Mugenda (1999) at least a response rate of 30.0% is acceptable in research.

4.2 Background Information of Respondents

Issues covered under the background of respondents include the age, formal education and experience of the respondents as a mechanic. Knowing the background characteristics of respondents was very necessary as that could help in determining the authenticity of the responses and as well as providing the basis for ascertain the use of

diagnostic equipment in the maintenance services of automobile vehicles and its impact on the wayside garage in Accra Metropolis.

4.2.1 Age of Respondents

The responses with regard to the age category of the respondents are presented in Figure 4.1

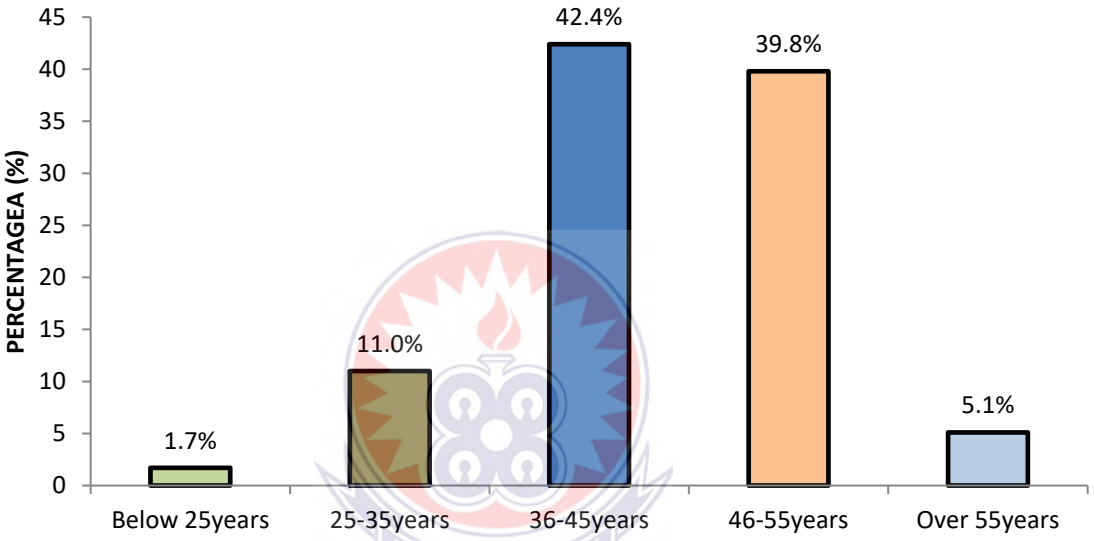

Figure 4.1: Age group of Respondents
Source: Field Survey, 2017

With regards to age of the respondents, Figure 4.1 clearly shows that the respondents were fairly distributed among the age brackets set out on the questionnaire. The statistics in the Figure 4.1 indicates that two respondents representing 1.7% were below 25years; 13 respondents representing 11.0% were between the age category of 25-35years; 50 respondents representing 42.4% were between the age category of 36-45years; 47 respondents constituting 39.8% were between the age category of 46-55years. The remaining 6 respondents constituting 5.1% were over 55years. From the statistics, it could be inferred that the majority (42.4%) of the auto mechanics from the

selected wayside garages in Accra Metropolis were aged between 36-45years. This suggests that majority of the respondents were matured and therefore could be captured in an academic study such as this.

4.2.2 Formal Education attained by Respondents

A section of the questionnaire was designed to capture the formal education of the respondents. The educational qualification of the respondents was presented in Figure 4.2.

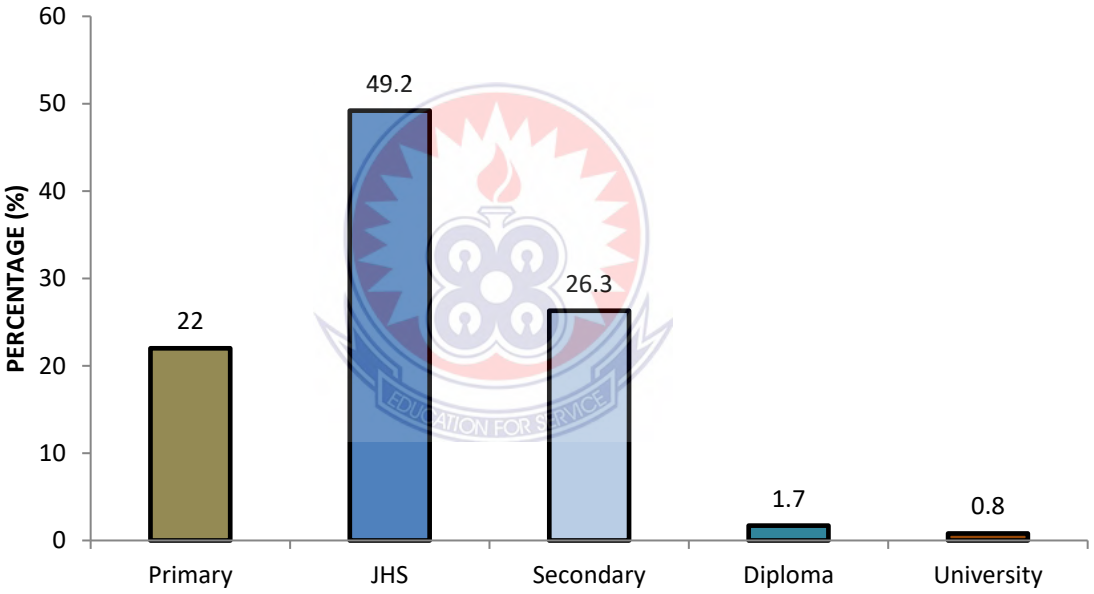

Figure 4.2: Formal Education of Respondents
Source: Field Survey, 2017

The study revealed that among the wayside mechanics who answered the questionnaires in Accra Metropolis, 26 respondents constituting 22.0%are primary school leavers and 58 respondents representing 49.2% were Junior High School (JHS) graduates. The results also revealed that 31 respondents forming 26.3% of the respondents were secondary school graduates. The study further showed that two respondents representing 1.7% hold Diploma. The remaining one respondent constituting 0.8% was a university

graduate. The findings concur with the study by Akpakpavi (2015) who indicated that auto mechanics in the selected automobile vehicle garages in Ghana have low levels of education. This low level of education of the auto mechanics has caused a major setback in that most of them are ignorant and not quite familiar with the advancing technological know-how of the trade. Some of them cannot read and write, and so find it difficult referring to instruction manuals, which has rather characterize modern auto repair practices. Again, the mechanics' low levels of education have resulted in situations where most of them find it extremely difficult identifying the components of modern electronic engines by their technical names correctly.

4.2.3 Working Experience of Respondents

The researcher was interested in finding out the experience of the auto mechanics. The findings are indicated in Figure 4.3

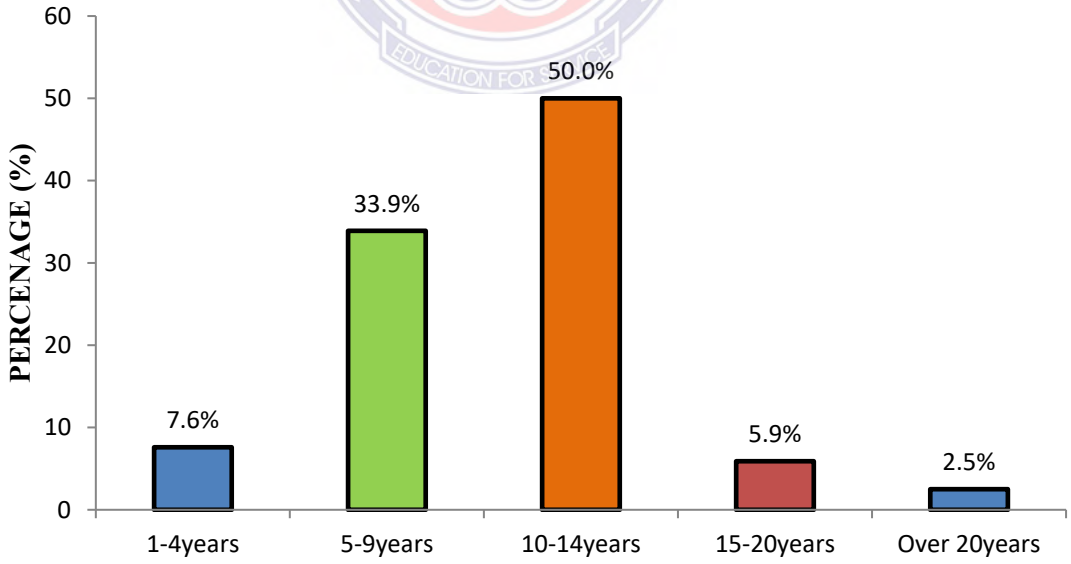

Figure 4.3: Working experience of respondents
Source: Field Survey, 2017

With regards to the number of years of working experience of the respondents, nine of them constituting 7.6% have had 1-4 years working experience, 40 respondents constituting 33.9% had between 5-9 years working experience, 59 respondents representing 50.0% had between 10-14years experience, seven respondents constituting 5.9% have had 15-20years experience, whiles only three respondents representing 2.5% had between over 20 years automotive maintenance working experience. This implies that the the auto mechanics at the seelcted wayside garages in Accra Metropolis are experienced and capable of exercising good judgment and as such the responses provided by them could be relied upon. However, despite their vast experience in automobile repair practices, most of the mechanics in the country find it difficult to diagnose and repair modern trends of automobile vehicles, especially modern electronic engines. The mechanics inability to repair and maintain modern automobile vehicles could be largely attributed to their low levels of education. As pictured in Figure 4.3, over 69.4% of auto mechanics in the Accra Metropolis possess educational levels way below secondary school levels.

4.3 Knowledge level of the wayside mechanics on diagnostic equipment

The main issue considered under this section related to the knowledge level of the wayside mechanics on diagnostic equipment in the maintenance services of automobile vehicles. Respondents were asked to indicate their level of agreement to statements on the knowledge level of the wayside mechanics on diagnostic equipment in maintenance service. The responses gathered with the aid of questionnaire administration are presented in Table 4.1.

Table 4.1: **Responses on the knowledge level of auto mechanics on diagnostic equipment**

Knowledge level	Reponses					Mean	Std. Dev.
	1=SD	2=D	3=N	4=A	5=SA		
The importance and value of diagnostic tools and equipment	---	---	5 (4.2)	68 (57.6)	45 (38.1)	4.34	.558
Aware of computer diagnostic machines and equipment used in diagnosing faults on automobile vehicles	1 (0.8)	15 (12.7)	7 (5.9)	65 (55.1)	30 (25.4)	3.92	.948
Adequate diagnostic tools and equipments to enable inspect and repair modern automobile vehicles	15 (12.7)	46 (39.0)	14 (11.9)	29 (24.6)	14 (11.9)	2.84	1.267
Experience on the use of diagnostic tools and equipment	19 (16.1)	49 (41.5)	12 (10.2)	25 (21.2)	13 (11.0)	2.69	1.278
Received training and re-training of auto-mechanics	63 (53.4)	32 (27.1)	9 (7.6)	4 (3.4)	10 (8.5)	2.02	1.997

Key: SD = Strongly Disagree, D = Disagree, N= Neutral, A = Agree, SA = Strongly Agree
*Source: Field Survey, 2017, **( )** Percentages in brackets, x-bar $\geq$3.0 =agreed*

It should be noted that responses for strongly agree and agree were merged in the write-up to mean 'agree' while that of disagree and strongly disagree were also merged to mean "disagree". However, that of neutral (N) was maintained in the write-up. From Table 4.1, item 1 sought to find out whether the auto mechanics are aware of the importance and value of diagnostic tools and equipment. Statistically, 113 respondents constituting 95.7% agreed to the statement, while five respondents constituting 4.2% were neutral to the statement that auto mechanics are aware of the importance and value of diagnostic tools and equipment. Akpakpavi (2015) indicated in his study that large number of the auto mechanics in Ghana are aware of the importance of diagnostic tools and equipment but do not have the knowledge in modern practices of automobile vehicle faults diagnosis, repair and maintenance.

On whether the respondents are aware of computer diagnostic machines and equipment used in diagnosing faults on automobile vehicles, 95 respondents constituting 80.5% agreed to the statement. Conversely, 16 respondents constituting 13.5% disagreed to the statement, while seven respondents constituting 5.9% remained neutral to the statement. The result indicates that wayside mechanics at Accra Metropolis are aware of computer diagnostic machines and equipment. According to the Automotive Body and Related Repairers (2014) auto mechanics are made aware of computer diagnostic machines for maintaining modern vehicle. The Automotive Body and Related Repairers reported that auto mechanics now regularly use the internet for information to help them in diagnosing and/or repairing vehicles. Service manuals for vehicles have become significantly less prevalent with computers that are connected to the Internet taking their position.

Again, concerning whether wayside garages have adequate diagnostic tools and equipment to enable inspect and repair modern automobile vehicles, 43 respondents representing 36.5% agreed to the statement. On the contrary, 61 respondents constituting 51.7% disagreed to the statement, while 14 respondents constituting 11.9% were neutral to the statement that there are adequate diagnostic tools and equipment to enable inspect and repair modern automobile vehicles. This implies that wayside garages in the Accra Metropolis did not have enough tools and equipments to enable inspect and repair modern automobile vehicles. Further conversation with the auto mechanics reveals that apart from not having most of the required basic tools and equipments, the garages also do not have modern vehicle diagnostic equipments such as: oscilloscope, scan tool, diagnostic code readers, computer diagnostic testers, internet connectivity, etc.

On the issue of whether wayside garages have experience on the use of diagnostic tools and equipment, 38 respondents forming 32.2% agreed to the statement. Conversely, 68 respondents representing 57.6% disagreed to the statement of being experience on the use of diagnostic tools and equipment. The finding reveals that auto mechanics at the wayside in Accra Metropolis do not have experience on the use of diagnostic tools and equipment. The finding concurs with the study by Akpakpavi (2015), most of the mechanics lack basic working experience and application of these diagnostic equipments. Not surprisingly, they are currently finding it extremely difficult to inspect, repair and maintain current trend of automobile vehicles leading to gradual job losses. The job of an auto mechanic has become increasingly specialized in the 21st century. It requires specialized equipment to diagnose problems with these sophisticated electronic devices (Chron, 2014). This enables the mechanics to accurately diagnose problems based on the latest information downloaded from manufacturer databases. Hence, auto mechanics today have to learn how to use modern electronic diagnostic equipment and be experienced.

The respondents were asked to determine whether they have received training and re-training of auto-mechanics, 95 respondents constituting 80.5% disagreed to the statement of receiving training and retraining after graduating as junior mechanic from post-secondary training center or apprenticeship training program and entering the job market as junior or senior mechanic, while nine respondents constituting 7.6% remained neutral. On the contrary, 14 respondents representing 11.9% disagreed to the statement that they have received training and re-training of auto-mechanics. From observations, the auto mechanics seem to be content with their current inadequate skills levels just

because they have the capability to maintain some vehicles, especially the old model of vehicles in the country. This implies that the wayside auto mechanics in Accra Metropolis hardly take advantage of the training programs organized by Mechanical LIoy, Toyota Ghana, Silver Star, Japan Motors and others. Affirmed by Mutmansky and Ramani (2006), to become proficient in a complex specialty such as automotive air-conditioning, electronic engine systems, transmission repairs as well as other similar specialty repairs might require another year or two of training or on the job experience. On-going training including classes at manufacturers' facilities to learn new technologies is common and technicians are expected to keep up with ever-changing systems through reading and on-the-job practice (Mutmansky & Ramani, 2006).

The results under the knowledge level of auto mechanics on diagnostic equipment reveals that the auto mechanics at the wayside know the importance and value of diagnostic tools and equipment, and aware of computer diagnostic machines and equipment used in diagnosing faults on automobile vehicles. The study further indicated that wayside garages do not have adequate diagnostic tools and equipments, are not experience on the use of diagnostic tools and equipment and have not received training and re-training of auto-mechanics. This indicates that to remain competitive in the globalize market, and to continue to function effectively in this 21st century, the garages in this country need to stock the relevant modern and even ultramodern tools and equipment necessary for modern car repairs. They should also endeavor to update and upgrade their technical competencies on the usage and correct working functioning of modern automobile vehicle repair tools and equipments.

4.4 Challenges faced by wayside mechanics in the advent of automobile technology

The main issue considered under this section related to the challenges faced by wayside mechanics in the advent of automobile technology. Respondents were asked to indicate their level of agreement to statements. The responses gathered with the aid of questionnaire administration are presented in Table 4.2.

Table 4.2: Responses on the challenges faced by wayside mechanics

Challenges	Responses					Mean	Rank
	1=SD	2=D	3=N	4=A	5=SA		
Lack of the required equipment (OBD scan tool)	2 (1.7)	13 (11.0)	9 (7.6)	65 (55.1)	29 (24.6)	3.90	1st
Complexity in the usage of diagnostic scan tools	9 (7.6)	10 (8.5)	11 (9.3)	69 (58.5)	19 (16.1)	3.67	2nd
Lack of proper upgrading of skills among the wayside mechanics	5 (4.2)	20 (16.9)	12 (10.2)	55 (46.6)	26 (22.0)	3.65	3rd
Expensive nature of diagnostic tools and equipment	12 (10.2)	16 (13.6)	2 (1.7)	65 (55.1)	23 (19.5)	3.60	4th
Lack of education on the use of the on-board diagnostic scan tool.	7 (5.9)	24 (20.3)	10 (8.5)	51 (43.2)	26 (22.0)	3.55	5th
Inadequate support by the government in the adoption of technology	10 (8.5)	35 (29.7)	12 (10.2)	50 (42.4)	11 (9.3)	3.14	6th
Infrequent supply of diagnostic tools and equipment for repairing	11 (9.3)	44 (37.3)	12 (10.2)	42 (35.6)	9 (7.6)	2.95	7th
Customers prefer traditional method of automobile repairing	24 (20.3)	53 (44.9)	8 (6.8)	24 (20.3)	9 (7.6)	2.50	8th
Wayside garages are interested in using traditional method of repairing automobiles	32 (27.1)	40 (33.9)	16 (13.6)	25 (21.2)	5 (4.2)	2.42	9th
Frequent breakdown of diagnostic tools and equipment	40 (33.9)	39 (33.1)	24 (20.3)	12 (10.2)	3 (2.5)	2.14	10th

Key: SD = Strongly Disagree, D = Disagree, N= Neutral, A = Agree, SA = Strongly Agree

Source: Field Survey, 2017, ***( )*** *Percentages in brackets*, **x**-*bar* $\geq$*3.0 =agreed*

It should be noted that responses for strongly agree and agree were merged in the write-up to mean 'agree' while that of disagree and strongly disagree were also merged to mean "disagree". However, that of neutral (N) was maintained in the write-up.As to whether lack of the required equipment (OBD scan tool) is one of the major challenges facing roadside mechanics in the Accra Metropolis, 94 respondents constituting 79.7% agreed to the statement, while nine respondents constituting 7.6% were neutral. On the other hand, 15 respondents representing 12.7% disagreed to the statement that lack of the required equipment (OBD scan tool) is one of the major challenges facing roadside mechanics in the Accra Metropolis with a mean score of 3.90 showing 1st in ranking. This is supported by Edunyah (2015), who affirmed that Lack of OBD scan tool was observed as one of the major factors contributing largely to the challenges facing roadside mechanics in the Tarkwa Township. The study revealed that out of the 50 respondents (representing 100%), of garage owners (roadside mechanics) in the Tarkwa Township only six of them (representing 12%) had a ODB scan tool for troubleshooting and diagnosing a problem.

On whether complexity of the usage of diagnostic scan tools posed a challenge to roadside mechanics, 88 respondents constituting 74.6% agreed with the statement. On the contrary, 19 respondents forming 16.1% disagreed to that effect, while 11 respondents representing 9.3% remained neutral with a mean score of 3.67 reflecting 2nd in ranking. This supports the findings of Jolly (2011) who indicated that complexity of a technology lead to increased uncertainty and perceived risk, and these in turn could lead to a resistance to adopt. Similarly, the finding is supported by the perceived attributes theory which stipulates that relative advantage, compatibility, complexity and observability are key influence to the adoption of technology within the informal automobile mechanics.

With reference that lack of proper upgrading of skills among the wayside mechanics is a challenge facing roadside mechanics in the Accra Metropolis, 81 respondents constituting 68.6% agreed to the statement. However, 25 respondents constituting 21.1% of the respondents disagreed, meanwhile, 12 respondents forming 10.2% were neutral to the statement. This statement had a mean score of 3.65 representing the 3rd in ranking order. The finding concurs with the study by Michael (2015) who investigated the various vehicle repair and maintenance practices using questionnaire administered on vehicle repair garages in the country. The findings revealed that a large number of the auto-mechanics in the garages in the country have considerable years of auto repair working experience but lack the ability to inspect and repair modern automobile vehicles due to lack of upgrading of skills among the wayside.

On whether expensive nature of diagnostic tools and equipment is a challenge to wayside mechanics in Accra Metropolis, 88 respondents forming 74.6% agreed to the statement. Conversely, 28 respondents representing 23.8% disagreed to the statement, while two respondents representing 1.7% were neutral to the statement that expensive nature of diagnostic tools and equipment is a challenge to wayside mechanics in Accra Metropolis. This statement had 3.60 mean score representing 4th in ranking. Again, on whether lack of education on the use of the on-board diagnostic scan tool posed a challenge to wayside garages, 77 respondents constituting 65.2% agreed to the statement, while 10 respondents forming 8.5% remained undecided to the statement. However, 31 respondents forming 26.2% disagreed to the statement that lack of education on the use of the on-board diagnostic scan tool posed a challenge to wayside garages. This rather had a mean score of 3.55 representing 5th in ranking. The study buttress with Edunyah

(2015) who affirmed that lack of education on the use of diagnostic equipment is a challenge among the roadside mechanics. Edunyah further asserted that only 6 of the garage owners, (representing 12%), had the basic knowledge in the repair of modern vehicles using the scan tool (OBDII) as they owned the tool. Aside from the normal practical skills, modern vehicle using OBD system require a complete knowledge of the function and operation of various parts before one can be able to carry out an effective repair on OBD- equipped vehicles.

Concerning whether inadequate support by the government in the adoption of technology is a challenge facing wayside garages in Accra Metropolis, 61 respondents forming 51.7% agreed to the statement, meanwhile, 12 of them forming 10.2% were neutral to that effect. On the other hand, 45 respondents forming 38.2% disagreed to the statement that inadequate support by the government in the adoption of technology is a challenge facing wayside garages in Accra Metropolis. This statement was rated 6th with a mean score of 3.14. Okuta and Dawha (2014) examined the concept of entrepreneurship development, the roles of government and non-governmental organizations, which revealed that the challenges is caused by inadequate funding in the adoption of technology.

The findings show that lack of the required equipment (OBD scan tool), complexity in the usage of diagnostic scan tools, lack of proper upgrading of skills among the wayside mechanics, expensive nature of diagnostic tools and equipment, lack of education on the use of the on-board diagnostic scan tool and inadequate support by the government in the adoption of technology are major challenges facing roadside mechanics in the Accra Metropolis.

4.5 Effect of diagnostic equipment on the maintenance services of wayside garages

This section sought to identify the effect of diagnostic equipment on the maintenance services of wayside garages in Accra Metropolis. Respondents were asked to state their level of agreement on statements relating to the effect of diagnostic equipment on the maintenance services of wayside garage. Table 4.3 shows the frequencies and percentages of respondents.

Table 4.3: Level of effect of diagnostic equipment on the maintenance services

S/N	Effect	Highly affected (34-50)		Moderately affected (17-33)		Low affected (1-16)	
		N	%	N	%	N	%
1.	Customers patronage of services	74	62.7	15	12.7	29	24.5
2.	Profit margin of the institution	35	29.7	29	24.6	54	45.8
3.	Survival of the business	83	70.3	6	5.1	29	24.6
4.	Quality of the repairs	79	66.9	4	3.4	35	29.7
5.	Trust from the customers	11	9.3	32	27.1	75	63.6

Source: Field Survey, 2017

As depicted in Table 4.3, 74 respondents constituting 62.7% indicated that the diagnostic equipment highly affect customer patronage service, whiles 15 of them constituting 12.7% indicated that diagnostic equipment moderately affect customer patronage service. However, 29 respondents forming 24.5% affirmed that diagnostic equipment affect the service of wayside garages lowly. The quality of service provided by mechanics has a major influence on customer satisfaction. With the aim of sustaining long term relationships with their customers, many businesses appreciate the use of technology as a business tool to keep their customers (Peng & Wang, 2006).

In addition, on whether the introduction of diagnostic equipment affects the profit margin of the wayside garages, 35 respondents forming 29.7% revealed that the introduction of diagnostic equipment highly affects the profit margin of wayside garages. On the other hand, 29 respondents constituting 24.6% affirmed the introduction of diagnostic equipment affects the profit margin of wayside garages moderately. However, majority (n=54) respondents constituting 45.8% indicated that the introduction of diagnostic equipment highly affects the profit margin of wayside garages. Furthermore, 83 respondents, representing 70.3% indicated that the introduction of diagnostic equipment highly affects the survival of wayside garages. However, 6 respondents constituting 5.1% mentioned that the introduction of diagnostic equipment affects the survival of wayside garages moderately. On the contrary 29 of them forming 24.6% mentioned that introduction diagnostic equipment affects the survival of wayside garages lowly. The findings confirm with the study by Lele (1997) who emphasized that survival of businesses is important in this time of economic recovery through modern vehicle diagnostic equipments to attract lost customers and renewing their confidence by means of effective service recovery strategies.

Again, 79 respondent representing 66.9% mentioned that introduction of diagnostic equipment highly affects the service quality of wayside garages, while 4 of them forming 3.4% indicated that introduction of diagnostic highly affects the survival quality of wayside garages moderately. Meanwhile, 35 respondents representing 29.7% affirmed that introduction of diagnostic highly affects the survival quality of wayside garages slowly. This finding is corroborated with Wanyeki (2014) who found out that most of roadside mechanics do not have the right equipment and many have had no

formal education in repairs of motor vehicles. With changes in motor vehicle technology, the mechanics have not kept up with the changes and this has had a negative impact on the quality of the repairs they undertake on motor vehicles.

Concerning the trust from the customers, 11 respondents representing 9.3% mentioned that introduction of diagnostic equipment highly affects trust from the customers, whiles 32 of them constituting 27.1% revealed that introduction of diagnostic equipment affects the trust from the customers moderately. However, the majority (n=75) of the respondents asserted introduction of diagnostic equipment lowly affects trust from the customers. In generally, the findings of the study show that the introduction of diagnostic equipment has affected customers patronage of services, survival of the business and the quality of the repairs of wayside garages in Accra Metropolis.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATION

This chapter sums up the findings from the study, draws conclusions arising from the study and makes relevant recommendations based on the findings.

5.1 Summary

Motor vehicles which were manually operated some centuries back are now electro-mechanically operated. Computers are common place in modern day automobile design; braking, steering, starting and suspensions system are few examples of items now technologically operated. In Ghana, most of the vehicle maintenance and repair jobs are performed by wayside mechanics and use what is termed the 'try and error' to repair almost all automobile. This research assesses the use of diagnostic equipment in the maintenance services of automobiles and its impact on the wayside garage in Accra Metropolis.

The specific objectives of the study were to: find out the knowledge level of the wayside mechanics on diagnostic equipment in the maintenance services of automobile vehicles; assess the challenges faced by wayside mechanics in the advent of automobile technology, and determine the effect of diagnostic equipment on the maintenance services of wayside garages in Accra Metropolis.

The study employed survey research design to elicit information on wayside garages. The main tool for data collection was structured questionnaire. Data was analyzed and presented by means of frequency distributions, percentages, tables and charts.

5.2 Summary of Key Findings

A number of findings were made after a discussion of the responses. They are summarized below;

5.2.1 Knowledge level of the wayside mechanics on diagnostic equipment

- The study found that auto mechanics at the wayside know the importance and value of diagnostic tools and equipment, and are aware of computer diagnostic machines and equipment used in diagnosing faults on automobile vehicles.
- The study further indicated that wayside garages do not have adequate diagnostic tools and equipment, they are not experienced on the use of diagnostic tools and equipment, and have not received training and re-training of auto-mechanics.

5.2.2 Challenges faced by wayside mechanics in the advent of automobile technology

- The study revealed that lack of required equipment (OBD scan tool), complexity in the usage of diagnostic scan tools, and lack of proper upgrading of skills among the wayside mechanics are the challenges faced by wayside mechanics in the advent of automobile technology.
- The study further revealed that expensive nature of diagnostic tools and equipment, lack of education on the use of the on-board diagnostic scan tool and inadequate support by the government in the adoption of technology are major challenges facing roadside mechanics in the Accra Metropolis

5.2.3 Effect of diagnostic equipment on the maintenance services of wayside garages

- The study showed that the introduction of diagnostic equipment affects customers patronage of services provided by wayside garages, survival of the business and the quality of repairs of wayside garages in Accra Metropolis.

5.3 Conclusions

The modern trend of mechanical services therefore requires the use of more complex and highly technological specialty diagnostic equipment to analyze vehicle faults for repair and service. As vehicle technology and maintenance processes are advancing, the problems facing automobile garages in the country have rather compounded. Although most of the auto mechanics in Accra Metropolis at the wayside know the importance and value of diagnostic tools and equipment, and are aware of computer diagnostic machines and equipment used in diagnosing faults on automobile vehicles. It appeared from the study that the wayside garages do not have adequate diagnostic tools and equipments, are not experience on the use of diagnostic tools and equipment, and have not received training and re-training of auto-mechanics.

The study revealed that wayside mechanics in Accra Metropolis lack the required equipment (OBD scan tool), and proper upgrading of skills.The study further revealed that expensive nature of diagnostic tools and equipment, lack of education on the use of the on-board diagnostic scan tool and inadequate support by the government in the adoption of technology are major challenges facing roadside mechanics in the Accra Metropolis.

The study concluded that the introduction of diagnostic equipment affects customers' patronage of services, survival of the business and the quality of repairs of wayside garages in Accra Metropolis. Therefore the government, the banks as well as other private organizations should assist to re-tool and equip the wayside garages in the country with modern equipments, especially the electronic vehicle diagnostic equipments such as oscilloscopes, scanners, diagnostic code scanners, computerized diagnostic testers, portable data link (PDL), exhaust gas analyzers and so no.

5.4 Recommendations

Based on the findings of the study and conclusions drawn from them, the following recommendations were made:

- The wayside garages that contribute to economic growth of the country should be given every opportunity to undergo a series of training to upgrade their technical knowledge in the use of the On-Board-Diagnostics tool (OBD) and basic vehicle electronics training with the support of automobile industries in Ghana and other relevant institutions.
- The government of Ghana should grant subsidy to roadside mechanics (entrepreneurs) to upgrade their knowledge in their trade area since it is likely to bring more benefits in terms of employment generation. The government of Ghana could also give these tools (scan tool) for these mechanics on hire purchase.

- Again, it is recommended that those who seek the services of these wayside garages should continue to do so since the study did not reveal a hopeless situation.

5.5 Suggestion for Future Research

Due to time and resource constraint, the survey was limited to wayside garages in Accra Metropolis, Ghana, it is thus recommended that a replication of this study would be helpful in reexamining the validity of its findings for which the researcher was not able to investigate. Further empirical studies using larger sample sizes from different and greater geographical location would be helpful in validating the use of diagnostic equipment in the maintenance services of automobile vehicles in Accra Metropolis. It is also recommended that both qualitative and quantitative research approach should be employed.

REFERENCES

Abdulsomad, K. (2000). Promoting Industrial and Technological Development under Contrasting Industrial Policies: The Automobile Industries in Malaysia and Thailand.*In* Industrial Technology Development in Malaysia, 274-300.

Adei, E. Adei, D. & Osei-Bonsu, S. (2011).Assessment of perception and knowledge of occupational chemical harzards, in the Kumasi Metropolitan spray painting industry, Ghana. *Journal of Science and Technology, 31(11), 83– 94.*

Agyapong, D. (2010). "Micro, Small, Medium and Large Enterprises' Activities, Income Level and Poverty Reduction in Ghana-A synthesis of Related literature", *International Journal of Business and Management*, 5(7), 198-199.

Akinola, A.O. (1995). "*Parts Standardization in the Motor Industry*".B. Eng. Thesis, Dept. of Mechanical Engineering Federal Univ. of Technology, Akure, Nigeria.

Akinola, B. & Ogedenge, T. (2005). "*Basic Automobile Technology*", Nigeria: Olajuyin Printers, Akure.

Akpakpavi, M. (2015). Modern automobile vehicle repair practices in micro, small and medium scale garages in Ghana. *International Journal of Science, Technology and Society,* 2(6): 216-222

Amoafo, O. (2012). Government Assistance and Growth of SMEs.*Daily Graphic*, p21

Anderson, M. & Harris, K. (2010) Biosynthesis of cyclotides. *Medical Journal,* 76: 227-69.

Aniekwu, N. (2007). Accidents and safety violations in the Nigerian Construction Industry. *Journal of Science and Technology (Ghana*), 27 (1), 81-89.

Appleton, K. (2012). Problem solving in science lessons: How students explore the problem space. *Research in Science Education*, *35* (4), 383-393.

Automotive Body and Related Repairers (2014). Factsheet: Career Information: Available at https://www.collegegrad.com/careers/insta06 [Accessed on 20th August, 2017]

Babakus, E & Boller, G. W. (1992). An empirical assessment of the SERVQUAL scale. *Journal of Business Research,* 24(3):253-268.

Baidoo, F. & Odum-Awuakye, G. A. (2015). Influence of service quality delivery in the SMEs of the motor vehicle repair service industry in Ghana. *African Journal ofApplied Research. (AJAR) Journal*, 1(1), 429- 439

Baidoo, F., & Odum-Awuakye, G. A (2017). Assessing customer satisfaction levels in the SMEs automobile vehicle maintenance and repairs service delivery system in Cape Coast – Ghana. *African Journal of Applied Research*, 3(1), 82-94.

Bailey, C. (2007). *A guide to qualitative field research.* (2nd ed.). London: Pine Forge Press.

Behara, E. T., Chowdhary, N. and Prakash, M. (2002).Prioritizing service quality dimensions. *Managing Service Quality*, 17(5), 493-509

Benitez, L., Cronin, J.J.Jr. & Taylor, S.A. (2007). Measuring service quality: A reexamination and extension.*Journal of Marketing,* 56 (2), 55-68

Bennett S, N. A., Kershaw, J. K., & Erjavec, E. (2006). *Heavy Duty Truck Systems* (4th Ed.).Boston: Houghton.

Best, J. W & Kahn, J. V. (2005).*Research in education* (9th ed.). Boston: Allyn & Bacon.

Betts, R., Welsh, H., & Ryerson, T. (2011).Tech Prep?Technology Education Relationship.*The Technology Teacher, 51* (5), 5-6.

Bitner, M. J., Faranda, W.T., Hubbert, A. R. & Zeithaml, V.A. (1997). "Customer contributions and roles in service delivery", International Journal of Service Industry Management, 8(3), 193-205.

Bouman, M. & Wiele, T.V.D. (1992).Measuring service quality in the car service industry: Building and testing and instrument. *International Journal of service Industry Management,* 3(4), 4-16

Brito, E.P.Z., Aguilar, R.L.B and Brito, L.A.L (2007). Customer choice of a car maintenance service provider: A model to identify the service attributes that determine choice. *International Journal of Operations & Production Management,* 27(5), 464-481.

Brown, S.W. & Bond, E.U. III (1995)."The internal/external framework and service quality: Toward theory in services marketing", *Journal of Marketing Management*, 2(9), 25-39.

Charette, R. N. (2009). This Car Runs on Code. *Journal on social social science*, 46(3), 3-9.

Chen, H.H. & Chen, S.C. (2009). The empirical study of automotive telematics acceptance in Taiwan: Comparing three technology acceptance models. *International Journal of Mobile Communications*, *7* (1), 50-65.

Chen, S. C. & Tang, L.L. (2002). Gender differs: Assessing a model of online purchase intentions in e-tail service. *International Journal of Service Industry Management*, *16* (5), 416-435.

Chen, S.C., & Ting, M. F. (2009). Determinants of Satisfaction and Continuance Intention towards Self-service Technologies, *Industrial Management & Data Systems*, *109* (9), 1248-1263.

Childress, V. W. (2011). Does integrating technology, science, and mathematics improve technological problem solving? A Quasi-experiment.*Journal of Technology Education, 19* (1), 16-26.

Chron, L. (2014). *Factsheet: What kind of Equipment does an auto mechanic use*.Available at http://www.work.chron.com/kind-eqiuipment-auto-mechanic-use-25000.html. [Accessed on 10th August, 2017].

Cohen, L., Manion, L. & Morrison, K. (2005).*Research methods in education* (5thed.). London: Routledge Falmer.

Creswell, J. (2012). *Research design: Quantitative, qualitative and mixed approaches*. (3nded.). Los Angeles: Sage Publications.

David A. H. (1989). From the American System to Mass Production -1800-1932.: Johns Hopkins University Press, Baltimore.

Dawodu R. A. (2001). The variable strategy for developing manpower production for sustainable poverty alleviation. *Technology Education and Poverty Alleviation inNigeria*: Proceedings of the 11th Annual Conference.

Dillon, A. & Morris, L. (1996).User acceptance of information technology. In W. Karwowski (Eds). *Encyclopedia of human factors and ergonomics,* 409-418. London: Taylor and Francis.

Dishaw, M.T. & Strong, D.M. (1999). Extending the technology acceptance model with task-technology fit constructs. *Information and Management*, *36*, 9-21.

Duffy, E. J. (1995). *Auto electrical and electronic Technology.* USA: Pearson Press.

Duffy, E. J. and. Scharff, R (2003). "Autobody Repair Technology", Cengage Learning, pp. 234- 250.

Edmunds, L. A. (2011). Communication and innovation implementation. *Academy of Management Review*, *9* (4), 704–11.

Edunyah, I. (2015). Technology and Modern Automobile Industry- Challenges and Opportunities for Roadside Mechanics in Ghana.(TarkwaNsueam

Municipality).*International Journal of Scientific Research and Innovative Technology,* 2 (6), 58-63

Ellis, L., Walsh, A., & Hartley, R. D. (*2010*).*Research* methods in criminal justice and criminology: An interdisciplinary approach. Sudbury, MA: Jones and Bartlett

Fernandez, M & Bedia, A. (2005).Applying SERVQUAL to diagnose hotel sector in a tourist destination, *Journal of Quality Assurance in Hospitality & Tourism,* 6(1):9-24.

Gana, P. J. and Bodams, A. C. (2004).“World Motor Vehicle Markets” Columbia Journal of World business.pp 81-93

Gay, L. R. (1996). Educational Research: Competencies for Analysis and Application. (3rd ed). London: Merrill Publishing.

Grover, V. &Güttler W. (2013). Some forecasts of the diffusion of e-assessment using a model. *The Innovation Journal, 15* (1) 56-87.

Growse, A. (2012). *Automotive mechanics* (8th ed.). New York: McGraw hill.

Hayden, M. A. (2009). What is technological literacy? *Bulletin of Science, Technology, and Society, 9,* 228-233.

Hofstee, E. (2006) *Constructing a Good Dissertation: A Practical Guide to Finishing a Master’s, MBA or PhD on Schedule (*p.135-136).Sandton: EPE.

Horovitz, J (1990). How to Win Customers – Using Customer Service for a Competitive Edge.*Longman, Harlow*.

Hunt, B.; William, J.; Kunz, L & Phil, R. (2000). *Extreme Muscle Cars: The Factory Lightweight Legacy.* Krause Publications.ISBN 978-0-89689-278-1. Retrieved 23-09-2014.

ILO, International Labour Organization {2000}.*International Data Sheet on Occupation*, Automobile Mechanics.ILO, Geneva.

Innova Electronics. (2011). *OBD 1 diagnostics*. Los Angelos: Author.

Innova Electronics. (2012). *Introduction to OBD 2 diagnostics*. Los Angelos: Author.

Iztok, P. &Krsto, P. (2014). Managing technologies within an industrial cluster: a case from a toolmakers cluster of Slovenia *International Journal of Technology management*, *66* (1), 301-317.

Jibodu, T. & Ude, L. (1996). Understanding technology: the development of a concept. *International Journal of Science Education, 18* (8), 977-992

Jing, M., Xuefeng, W.; Donghua, Z. & Xiao Z. (2015).Analysis on patent collaborative patterns for emerging technologies. *International Journal of Technology Management*, *69* (3), 210-228

Johnson, S. D. (2009). Making the transition to technology education: Lessons from the past. *The Technology Teacher, 88* (5), 9-12.

Jolly, A. (2011). *The innovation handbook* (2nd ed). London: Kagan Page.

Juneseuk, S. &Hakyeon L. (2013). Low-risk opportunity recognition from mature technologies for SMEs.*Journal of Engineering and Technology Management, 30* (4),402-418.

Khalil, L. &Tarek, M. (2000).*Management of technology.the key to competitiveness and wealth creation.* Mexico City: Mcgraw-hill higher education.

Koscher K., Czeskis, A., Roesner, F., Patel, S., Kohno, T., Checkoway, S. & Savage, S. (2010). Experimental Security Analysis of a Modern Automobile. Journal on IEEE Security and Privacy, 5 (3), 447-462.

Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Delhi: New Age International (P) Ltd., Publishers.

Kotler, P.(2000). Marketing Management.Millennium Edition. Upper Saddle River, New Jersey: Prentice Hall.

Krejcie, R. V., & Morgan, D.W., (1970).Determining Sample Size for Research Activities.*Educational and Psychological Measurement*

Krejcie, R.V. & Morgan, D.W. (1970).Determining sample size for research activities. *Educational and Psychological Measurement,* Vol. 30, 607-610.

LaPorte, J. & Sanders, M. (2013).Integrating technology, science, and mathematics in the middle school. *The Technology Teacher, 72* (6), 17-21.

Lee, M.C. (2009). Factors influencing the adoption of internet banking: An integration of TAM and TPB with perceived risk and perceived benefit. *Electronic Commerce Research and Applications*, *8* (3), 130-141.

Lele, M. (1997). After-Sales Service - Necessary Evil or Strategic Opportunity?*ManagingService Quality: An International Journal*, Vol. 7 Issue: 3, pp.141-145, doi: 10.1108/09604529710166914 http://www.emeraldinsight.com Retrieved March 2017.

Lemurzone, T. (2012). Automotive electronics: Airbag inflators. Clemson University Vehicular Electronics

Leung, D. (1998).Emerging technologies in the automotive industry. *European Journal of Innovation Management, 12,* 104-126

Lewis, T. &Gagel, C. (2012). Technological literacy: A critical analysis. *Journal of Curriculum Studies, 24* (2), 117-138.

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

Liou, J. & Chen, C. S. (2006). A case study of an inter-enterprise workflow-supported supply chain management system. *Information & Management*, *42* (3), 441-454.

Martin, T. (2015).*How to Use Automotive Diagnostic Scanners*. Minneapolis: Quarto Publishing Group USA Inc.

Michael, A. (2015). Modern automobile vehicle repair practices in micro, small and medium scale garages in Ghana. *International Journal of Science, Technology and Society*, 2(6), 216-222.

Miller C. & Valasek, C. (2015). Remote Exploitation of an Unaltered Passenger Vehicle. Las Vegas: on Black Hat USA.

Miller, C. & Valasek, C. (2013). Adventures in Automotive Networks and Control Units [Conference] // DEF CON 21. - Las Vegas, 260-264.

Modern Riders, (2014).*Factsheet: How Modern Cars Engines are Different.* Retrieved from http://www.modernrides.com/how-modern-car-engines-are-dif. Accessed on 20th August, 2017.

Morgan, S. (2014). *Autonomous cars: Self-Driving the New Auto Industry Paradigm*. New York: Morgan Stanley & Co. International.

Mugenda, O &Mugenda, A.G. (1999).*Research methods*. Nairobi: Acts Press

Mugenda, O. M. (1999). *Research methods: Quantitative and qualitative approaches*: Olive M Publication: Nairobi Acts 1999, 256p.

Muijs, D. (2004). *Doing quantitative research in education with SPSS*. London: Sage Publications Publications.

Mutmansky, J. M. & Ramani, R. V. (2006).*11th US/North American Mine Ventilation Symposium,* USA: CRC Press, 89-110.

Neuman, W. L. (1997). *Social research method: qualitative and quantitative approaches*. (5th ed.). New York: Allyn & Bacon.

Ngure, S. W. (2013). "Where to vocational education in Kenya: Is analyzing training and development needs the answer to the challenges in this sector?" *Journal of Education and Vocational Research*, *4* (6), 193-204.

O'Lary, Z. (2004). *The essential guide to doing research*. New Delhi: Sage Publications Publications India Pvt.

Okuta, S. and Dawha, J.M., (2014). Challenges of automobile technology in entrepreneurship development. *International Letters of Social and Humanistic Sciences*, (32), 166-174.

Olalekan, O. B. (2001). Remote Control of Electrical Loads Using GSM Module. Journal of Industrial Technology, 2 (2): 38- 50.

Owston, R. (2013). Contextual factors that sustain innovative pedagogical practice using technology: An international study. *Journal of Educational Change, 8* (1), 61-77.

Parasuraman, A, Zeithaml, V & Berry, L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, 49(4):41-50.

Parasuraman, A, Zeithaml, V & Berry, L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing,* 64(1):12-40.

Parasuraman, A, Zeithaml, V & Berry, L. (1991). Refinement and reassessment of the SERVQUAL scale. *Journal of Retailing,* 67(4):420-450.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985).A Conceptual Model of Service Quality and its Implications for Future Research. *Journal of Marketing*, 49, 41-50.

Peng, L. Y., and Wang, Q. (2006).*Impact of Relationship Marketing Tactics on Switchers and Stayers in a Competitive Service Industry*, Journal of Marketing Management, V.22, pp.25-59.

Pucel, D. J. (2008). Technology education: A critical literacy requirement for all students. Paper presented at the 79th Mississippi Valley Industrial Education Conference, Chicago, Il.

Pucel, D. J. (2014).Developing technological literacy: A goal for technology education.*The Technology Teacher*, *73* (3), 35-43.

Rahim, J. A., Ladipo, E. & Kunle, S. E. (2013).Service encounters and service relationships: Implications for Research. *Journal of Busmess Research*, Vol20, p.13-21.

Ribbens, W. B. (1998). U*nderstanding automotive electronics (5th ed.)* Japan: Pearson Edu, press.

Robbins, S. T., & Judge, T. A. (2007).*Organisational behaviour*.Japan:Pearson Education Japan.

Rogers, E. M. (1962). *Diffusion of Innovations*. New York: Collier-Macmillan.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press

Rogers, E. M. (2003). Diffusion of innovations (5th ed.). New York: Free Press.

Rongers, E., Medina, U., Mario, R. & Cody W. (2004).Complex adaptive Systems and the Diffusion of Innovations. *The Innovation Journal: The Public Sector Innovation Journal, 10* (3), 41-54

Santini, A. (1992). *Automotive electronic* (2nded.). London: Sage Publication.

Serenko, A., Nick, B. &Sacerdoti, E. (2007). Longitudinal knowledge strategizing in a long-term healthcare organization. *International Journal of Technology Management*, *1* (3), 67-89.

Shield, G. (2013). Formative influences on technology education: The search for an effective compromise in curriculum innovation. *Journal of Technology Education, 23*(1), 50-60.

Shukla, P. (2008). *Essentials of marketing research*.[On line]. Available at: http://www.Bookboon.com. (Accessed on 24 October, 2017).

Stern, N., Peters, S., Bakhshi, V. & Bowen, A. (2008). *The economics of climate change*. Cambridge: Cambridge University Press.

Stockburger, A. (2007). Fundamental of Educational Research: An Introductory Approach. London: Scott, Foresman and Company.

Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research*, *79* (2), 625–649.

Taha, S.M. (2000). Measuring service quality in the car service agencies.*Journal of Applied Sciences,* 9(24), 4258-4262.

Tetteh B. (2015). *Building an African Vehicle* .Myjoyonline.com Retrieved 7th March, 2017

Tornatzky, L.G., & Klein, R.J. (2011). Innovation characteristics and innovation adoption implementation: A meta-analysis of findings. *IEEE Transactions on Engineering Management*, *29*(1), 28–45.

US Department of Labour statistics (2012). *Information economy report*. New York and Geneva: Author.

Valuri, S.&Routley, G. (1994).The analysis of antecedents of customer loyalty in the Turkish mobile telecommunication market.*European Journal of Marketing.*39 (7/8) p.910-925.

Van de Sande, A, & Schwartz, K. (2011). Research for Social Justice: A Community-based Approach, Halifax: Fernwood Publishing.

Venkatesh, V. & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies., *Management Science, 46* (2), 186–204.

Vyas, E. T., Cronin, J.J.Jr. and Taylor, S.A. (2011).SERVPERF versus SERVQUAL: Reconciling performance-based and perceptions-minus-expectations measurement of service quality. *Joumal of Marketing,* 5(8), 125-131

Wanyeki, P. M. (2014). Adoption of new technology by jua kali automobile mechanics in Eldoret municipality. *CIGR Journal of Scientific Research and Development*, Invited Overview Paper, IX: Moi University.

Ward D., Ibarra I. & Ruddle A. (2013). Threat Analysis and Risk Assessment in Automotive Cyber Security.*International Journal on Passengers Cars – Electron. Electronic System*, 2 (6), 43-51.

Wicklein, R. C. (2012). Identifying critical issues and problems in technology education using a modified-delphi technique, *Journal of Technology Education, 21* (6), 54-71.

Wiele, G. (1992). How to Make After-Sales Services Pay Off. McKinsey Quarterly, 4:116-127 http://business.myjoyonline.com/pages/news/200804/15255.php

Williams, C. and Zigli, M. L. (1987).The Impacts of Relationship Marketing Tactics on Relationship Quality in Service Industry.*The Business Review: Cambridge.* 7 (2) p.310-314.

World of Work Report (2012). Revolution in the automobile industry.*The International Journal of Entrepreneurship and Innovation*, *14* (2), 45-59.

Yeh, E.M. and Kuo, L. (2003).The relationship between service quality and customer satisfaction-a factor specific approach*, Journal of Services Marketing*, 16(4), 363-379.

Zafiropoulos, C &Vrana, V. 2008.Service quality assessment in a Greek higher education institute.*Journal of Business Economics and Management*, 9(1): 33-45.

Zeithaml, V. A., Parasuraman, A., & Berry, L. L. (1990). Delivering Quality Service, The Free Press, New York, N.Y

APPENDIX A

SAMPLE SIZE DETERMINATION

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.
S is sample size.

APPENDIX B

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

TOPIC

THE USE OF DIAGNOSTIC EQUIPMENT IN THE MAINTENANCE SERVICES OF AUTOMOBILES AND ITS IMPACT ON THE WAYSIDE GARAGE (A CASE STUDY IN THE ACCRA METROPOLIS)

Preamble: I am a postgraduate student of the University of Education, Winneba undertaking a research on the above subject area. It would be greatly appreciated if you could complete this questionnaire. The study is purely for academic purpose and nothing else. Be assured that your response will not in any way be linked to your identity. You are kindly requested to answer the questions below by indicating a tick (√) or writing the appropriate answer when needed. Thank you

Section A: Socio-demographic characteristics

1.0 What is your age (years)?

Below 25 ( ) 25-35 ( ) 36-45( ) 46-55 ( ) Over 55 ( )

2.0 Formal education

No formal education ( ) Primary ( ) JHS ( ) Secondary ( )

Diploma ( ) University ( )

3.0 Have you undertaken any technical training? Yes ( ) No ( )

If "Yes", what qualifications do you possess?

Higher National diploma ( ) Part I - Part III( ) Intermediate ( )

NVTI I &II ( ) Other (specify):……..

4.0 What is your experience?

1-4 ( ) 5-9 ( ) 10-14 ( ) 15-20 ( ) Over 20 years ( )

5.0 Given a chance, will you go for further training?

Yes ( ) No ( )

If yes, which skill would you wish to learn?:……

6.0 Do you experience any challenges while working on modern vehicles?

Yes ( ) No ( )

If yes, what challenges?

……

……

SECTION B: Wayside Garage Opinion on the use of Diagnostic Equipment

6.0 To what extent do you agree or disagree with the following knowledge level of the use of diagnostic equipment in the service delivery of automobile vehicles. Please rate your responses using a scale of 1 to 5: Strongly disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly agree (5). **Please tick the box which best reflect your view and state briefly where necessary**

Knowledge level	**Score**				
	1	**2**	**3**	**4**	**5**
The importance and value of diagnostic tools and equipments					
Received training and re-training of auto-mechanics					
Aware of computer diagnostic machines and equipments used in diagnosing faults on automobile vehicles					

Adequate diagnostic tools and equipments to enable conveniently and speedily inspect and repair modern automobile vehicles are available					
Experience on the use of diagnostic tools and equipment					
Knowledge on computerized diagnostic tools and equipments					

7.0 To what extent do you agree or disagree with the following challenges faced in the advent of automobile technology advancement. Please rate your responses using a scale of 1 to 5: Strongly disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly agree (5). **Please tick the box which best reflect your view and state briefly where necessary**

Challenges	**Score**				
	1	**2**	**3**	**4**	**5**
Lack of the required equipment (OBD scan tool)					
Inadequate support by the government in the adoption of technology					
Lack of education on the use of the on-board diagnostic scan tool.					
Lack of proper upgrading of skills among the wayside mechanics					
Complexity in the usage of diagnostic scan tools					
Expensive nature of diagnostic tools and equipment					

Customers prefer traditional method of automobile repairing					
Wayside garages are interested in using traditional method of repairing automobiles					
Infrequent supply of diagnostic tools and equipment for repairing					
Frequent breakdown of diagnostic tools and equipment					

8.0 To what extent do you agree or disagree with the following statement on the reasons car owners send their cars to wayside garages at the expense of diagnostic equipment in the maintenance services of automobile vehicles. Please rate your responses using a scale of 1 to 5: Strongly disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly agree (5). Please tick the box which best reflect your view and state briefly where necessary

Statement	**Score**				
	1	**2**	**3**	**4**	**5**
Easily accessible					
Customers can negotiate the service charge					
Customers have nochoice					
A good service is assured					
Good place to relax					
Low workmanship charges					

9.0 In your opinion to what extent has the introduction of diagnostic equipment affected maintenance service of wayside garages? Please rate using a scale of 34-50 represents highly affected, 17-33 represents moderately affected, 1-16 represents low affected. Please tick [√] the appropriate box.

S/N	Statements	Highly affected (34-50)	Moderately affected (17-33)	Low affected (1-16)
1.	Customers patronage of services			
2.	Profit margin of the wayside garages			
3.	Survival of the business			
4.	Service quality of the mechanics			
5.	Practices of the wayside garages			
6.	Trust from the customers			