

## Assessing the Knowledge and Impact of Advanced Automobile Technology on Repair Business of Informal Automobile Mechanics in Ghana (Ho Municipality).

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**Abstract-** Repeated surveys have shown that informal automobile mechanics lack knowledge on modern technology in automotive systems which affects their repair businesses. This study focuses on diagnostic abilities, knowledge of informal automobile mechanics (technicians) on advanced automobile technology and the impact advanced automobile technology is having on their repair business. Data for the study was collected through three techniques namely observation, survey (questionnaires) and interview. The automobile mechanics were sampled randomly whereas modern vehicle owners were purposely sampled. The data was analyzed using Statistical Package for Social Scientist (SPSS) version 16 software. The result from the study shows that the introduction of advanced technology into modern vehicles is affecting the business of informal automobile repair garages negatively (84.6%) and gradually sending informal automobile mechanics out of business. The results of linear regression coefficient and one-way between group ANOVA analysis revealed a positive statistically significant correlation between impact on repair business and knowledge of respondents on advanced automobile technology ( $p < 0.00$ ). The study concluded that the main factor that contribute to lack of knowledge of respondents on advanced automobile technology is low education. Informal automobile repair sector contributes to the development of a country's economic growth, Government needs to pay attention to local automobile repair workers in order to help improve the situation through the various competent based programs in the country such as National Board for Small Scale Industries (NBSSI), Skills Development Fund (SDF) initiative, Gratis Foundation and any other assistant that can be extended.

**Index Items-**Advanced Automobile Technology, Ghana, Informal automobile mechanics, Modern Vehicle.

### 1) INTRODUCTION

The automotive sector is considered one of the most important for a country's economy and trade because it shapes the industry, the cities, communal and individual life [21] According to [22] digitization will drive more innovation in the automotive industry in the next 20 years than there has been in the past 100 years. The digital transformation of the automotive industry is, in effect, the innovative reassembly of customer and company resources, and of products and services, in order to grow value, revenue and efficiency via digital technologies. A similar story could be told with respect to the spread of digital technology for monitoring every aspect of engine performance. The pace of technological improvements, influenced by regulatory pressure, continues to grow. Technology to reduce the environmental footprint of motor vehicles will be even more vital in the future [10]. The

legislators seek continued reductions in emissions and the vehicle manufacturers have been able to achieve tremendous results, but without technology (electronics) it would not have been possible to reduce emissions to anywhere close to the current low levels [13]. With this projection of digital or technological transformation in the automotive industry, the question of how the informal automobile mechanics would adopt to the change in technology in order to help safe and reliable road transportation in the years to come is yet to be fully studied. Meanwhile, a study conducted by [15] in Kenya indicate that adoption of modern technology in automotive system ensures accurate and reliable diagnoses, repair and or service of vehicles by use of on-board diagnostic scanners and thus lowering maintenance costs as in fuel consumption and less frequent repairs, maximum safety and a cleaner environment. Unfortunately, a significant proportion of motor vehicle mechanics in Kenya are yet to appreciate these relative advantages. It is critical for the informal auto mechanics to adopt and appreciate the advantages of modern automobile technology in order to alleviate the possible challenges [15]. According to a similar study conducted in Ghana by [1] informal automobile mechanics lack the ability to inspect and repair modern automobile vehicles due to low educational and technical levels. The researcher also indicate that informal auto mechanics also lack the ability to identify and use modern diagnostic equipment, manufacturers' manuals, computers and internet which have characterized modern vehicle repairs, in their repair practices. [6] state that the continual increase in the use of electronics within vehicles represents a major challenge for customer service and workshop operations. Quick and reliable fault diagnosis in modern vehicles require extensive technical knowledge, detailed vehicle information, up-to-date testing systems and the skill to be able to apply all these. However, [18] indicate that modern diagnostics requires a fundamentally different approach than that for traditionally controlled engines because it requires more sophisticated equipment than was required for diagnostics in pre-emission-control automobiles. It is, therefore, inevitable for the mechanics to adopt to these innovations if they are to remain competitive in the industry [16]. The aim of this study, therefore, is to assess the diagnostic abilities, knowledge of informal automobile mechanics on modern automobile technology and the impact this has on their repair businesses in order to identify areas where improvements are needed.

### 1.2 Technologies in automotive systems

In recent times, the automobile industry has witnessed much technological advancement. The most important one to be built into vehicles has to be the Engine Management System. It is the brain of the car that controls the fuel supply and the ignition by combining the two separate functions into one main system [5]. The Engine Management System controls the whole of the combustion process, making the engine more

efficient and less polluting than ever before. Also, automatic cruise control technology to adaptive front lighting system etc. These advanced technologies work on a set of dedicated sensors and ECUs, which are programmed to control the functioning and operation of these technologies. The inclusion of such products in the vehicles has increased the complexity of the vehicles electronic/electrical architecture. In case of any faults in such systems, it is very difficult to diagnose manually. But, with the development of diagnostic scan tools, diagnosis and rectification of faults in such systems has been eased as well as the time taken to perform the same task is reduced to a great extent [5], [11]. The modern engine management system has a self-test capability that regularly examines the signals from engine sensors and in some instances the actuators. In the event of a fault being present the ECU internally logs a code. This code can be extracted from an output terminal, known as a diagnostic plug or socket or serial port, by a suitable On-Board diagnostic (OBD) fault code reader or scan tool [17]. On-board diagnostics (OBD) is an automotive term referring to a vehicle's self-diagnostic and reporting capabilities. Tools with OBD allow mechanics and vehicle manufacturers to connect to the vehicle's on-board computers and diagnose any potential failures in the engine, as well as retrieve information such as revolution per minute (rpm), horse-power [7]. In addition to engine functions, the automatic transmission, anti-lock brakes, air bag and various body control systems may now be controlled via individual computers that must also be diagnosed by using an OBD scan tools [4].

### 1.3 Knowledge required for efficient auto repair work.

Automobile repair is typically performed by automobile mechanics that have experience in auto diagnostics. Determining the issues of a defective automobile is a skill that takes many years to develop. There are different types of diagnostic techniques in use today. These include computer tests, road tests, customer interviews, and basic problem-solving techniques. Automobile defects are typically divided into three primary categories. These are the motor, the drive train, and general electronics. Auto diagnostics requires an understanding of each category. The mechanic will use different diagnostics techniques depending on the category of the defect. Computer diagnostics is typically required for most modern cars. These computer devices are connected to the automobile with special software that reads the on-board diagnostic system [20]. As technical systems become more and more complex and the demands for safety, reliability and environmental friendliness are rising, fault diagnosis is becoming increasingly important. One example is automotive systems, where fault diagnosis is a necessity for low emissions, high safety, high vehicle uptime, and efficient repair and maintenance [19]. [12] indicate that over recent years, the amount of electrical and electronic equipment has increased considerably, and this trend is likely to continue into the next decade. It should be noted that serious problems are likely to occur on modern vehicles if the person undertaking a repair does not understand the basic construction and operation of both the mechanical and electrical or electronic systems. This is particularly important in the field of diagnosis, because

ignorance in either one of these areas of knowledge can lead to component damage and costly repairs. Whereas in the past, most repair activities on a motor vehicle could be divided into either mechanical or electrical tasks, nowadays the systems are fully integrated. According to [8] the days of being only mechanically inclined are gone for most roadside mechanics. The general engineering mechanic and roadside mechanics or diagnosticians must be able to understand and appreciate the use of technology as a business tool.

### 1.4 The challenge for informal automobile mechanics

Ghana has witnessed a tremendous increase in used vehicle importation. This is because of the high demand for on-road transportation in both rural and urban centers. Since Ghana is not a vehicle manufacturing economy, all vehicles are imported with most of them being second-hand vehicles [3]. According to [14] the track record of vehicle importation in Nigeria tends to indicate an upward trend and this has resulted in an increased growth of automobile repair services sector in the country. Informal auto mechanics are those that repair these vehicles in Ghana. However, currently, most of the micro, small and medium scale vehicle repair garages in the country are faced with numerous challenges including: Low capital and infrastructure base, inability to acquire and use modern vehicle diagnostic equipment and tools, low educational levels, lack of training and re-training, inability to use computers and internet facilities for vehicle repairs, inability to identify parts of modern vehicle engines by their correct technical names and functions [1], [8]. A study conducted by [14] reported that Nigeria still witnesses slow growth in its repairs and maintenance services because cars have become more complicated and computerized, thus requiring specialized tools, skills and computer software for service and repair. Automobile mechanics in informal sector have been slow in adopting modern technology despite the advantages that are attributed to new innovations [16], [11] pointed that engine management systems of vehicles are very complicated electronic systems and any work carried out by untrained personnel can result in unnecessary damage and expense. [6] states that the knowledge needed for accurate diagnostics is in two parts: understanding of the system in which the problem exists and having the ability to apply a logical diagnostic routine. [8] recommended that for a country like Ghana to sustain and support businesses, roadside mechanics who contribute to economic growth of the country should be given every opportunity to undergo a series of training to upgrade their technical knowledge

## 2) METHODOLOGY

### 2.1 Study area

The study was carried out in Ho municipality the capital of Volta Region in Ghana which is recently witnessing rapid urbanization and therefore selected for this study in order to identify road transport challenges as far as automotive remains the major means of transportation within the Region. Government formal sector works, and private businesses are the main occupations of the people in the city and all kinds of vehicles are being used in the city with varying ages and maintenance levels or records [3].

2.2 Research design and data collection methods

This study adopted three main methods of data collection: observation, survey (questionnaires) and interview. In order to motivate respondents to participate and give details of the situation currently on ground, OBDII Fault codes and its likely causes were printed and given to each master mechanics as a means of the researchers' contribution to knowledge.

In general, a total of 151 responses were valid for analysis out of 166 respondents contacted within the municipality giving a response rate of 90%. The first stage of the data collection was administering of open and close-ended questionnaires to (65) informal automobile master mechanics using random sampling method. During the administration of the questionnaires mechanics who could not read and write had the questions interpreted for them in the local language (Ewe). In the second stage, mechanics were given OBDII Diagnostic scan tool to identify a fault which has been created by the researchers in an engine of a modern vehicle. The master mechanics were observed as they used the OBDII scan tool. The last stage of the data collection method was an interview with vehicle owners in the area. Eighty-six (86) modern vehicle owners were purposely selected and interviewed. The informal auto mechanics who specialize in auto electrics, petrol and Liquefied Petroleum (LPG) powered engines were considered in this study.

2.3 Data analysis

The data from the questionnaires and the observational charts were coded and entered into Statistical Package for Social Scientist (SPSS) version 16. A linear regression coefficient and one-way between group ANOVA analysis were conducted.

3) RESULTS AND DISCUSSIONS

3.1 Demographic characteristics of respondents

As shown in Table I. all the informal automobile repair mechanics who participated in the study were males (100%). A study conducted in the same study area by [2] to investigate the relationship between workshop operations and accidents in local automobile garages in Ghana confirmed the result and explained that this is because the automobile industry is mostly a masculine occupation in Ghana and therefore, not common to see females involved in the vehicle repair business. Majority of the respondents were above 40 years (63.1%) but with lower education level that is, completed only junior high or middle schools (76.9%). However, they have been working in the automobile repair sector for more than 15 years. This implied that most of the respondents had enough work experience in the automobile repair sector and could be used to attain the objectives of the study.

Table I Demographic characteristics of respondents (only automobile mechanics)

Characteristics		Frequency	Percentages (%)
<b>Gender</b>	Male	65	100
	<b>Age</b>		
	18-25	5	7.7
	26-32	6	9.2
	33-40	13	20
	above 40	41	63.1
	Total	65	100
<b>Education</b>	JHS/Middle	50	76.9
	Vocational/Technical	13	20
	Polytechnic	2	3.1
	Total	65	100
<b>Experience</b>	> 5	7	10.8
	6-10	5	7.6
	11-15	7	10.8
	15	46	70.8
	Total	65	100

\*Age and Experience values in years.

Table II Knowledge of respondents on various automobile technology

Independent Variables	Unstandardized	Standardized			
	Coefficients	Beta	t	P-value	
	B	Std. Error			
<b>Knowledge on engine management system (EMS)</b>					
Sensors	-.228	.092	-.288	-2.484	.018
Actuators	-.303	1	-.333	-3.033	.004
ECU	-.2434	.134	-.232	-1.871	.066
<b>Knowledge on other vehicle Systems</b>					
Traction control system (TCS)	-.967	.213	-.883	-4.550	.000
Anti-lock braking system (ABS)	.461	.142	.461	3.245	.002
Cruise control system (CSC)	-.809	.178	-.775	-4.554	.000
Continuously variable transmission (CVT).377		.145	.377	2.600	.013
<b>Knowledge on On-board diagnoses (OBD)</b>					
Able to use OBD Scan Tool	-.661	.217	-.358	-3.047	.003
Malfunction Indicator Lamp (MIL)	-.402	.146	-.424	-2.760	.008
Diagnostic Trouble Code (DTC)	-1.925	.399	-1.135	-4.829	.000
Controller Area Network (CAN)	1.300	.371	.982	3.500	.001
Availability of Modern Tools	-.561	.154	-.417	-3.637	.001

\*Dependent Variable: Education, significant interval is set at (P<0.05)

To assess the knowledge of respondents on automobile technology, a linear regression coefficient analysis was adopted, and the results presented in Table II show that almost all the independent variables were statistically significant except the knowledge of respondents on electronic control unit (p>0.066). However, respondents demonstrate a fare knowledge on sensors (p<0.018) and continuously variable transmission (p<0.013). The Table 2 also shows statistically significant (p<0.003) result of diagnostic capabilities of respondents using OBDII scan tool to diagnose the fault of a

modern vehicle. During this stage of data collection, observations were made, and key attention was paid to the ability of respondents' locating diagnostic connector in the vehicle, turning ignition key off before connecting the tool, and interpretation of diagnostic trouble code as a means of navigating to the problem. At the end of the process it was observed that mechanics that were not able to use the tool were frustrated but were opting to use their try and error method to trace the fault.

Table III Linear regression ANOVA result for education and factors affecting knowledge of respondents on modern automobile technology

Factors	Sum of Squares	df	Mean Square	F	P-value
Knowledge on ECM	8.34	3	2.78	20.66	0.000
Knowledge on other vehicle modern systems	21.512	4	5.378	81.541	0.000
Knowledge on OBD	6.434	4	1.609	9.537	0.000
Availability of modern scan tools	2.872	1	2.872	13.225	0.001

\*Dependent variable: Education. significant interval is set at (P<0.05)

In determining the effect of educational level as a contributor to lack of knowledge of respondents on automobile technology, a linear regression ANOVA test was used, and the results in Table III revealed that all the independent variables against the dependent variable only model were statistically significant at alpha 0.05 level based on education. Knowledge on engine management system (p<0.00), knowledge on other vehicle systems (p<0.00), knowledge on on-board diagnostic system(p<0.00), and availability of modern diagnostic tools (p<0.00). This imply that education is a key factor in determining the knowledge of informal mechanics on advanced automobile technology. Also, this study could conclude that the more educated an automobile mechanic is the more knowledgeable he becomes in terms of availability and the necessary diagnostic tools needed for the automobile repair business. Knowledge, skills on modern automobile technology or systems and availability of modern diagnostic tools are prerequisite for effective and efficient diagnosis and repair of a modern vehicle.

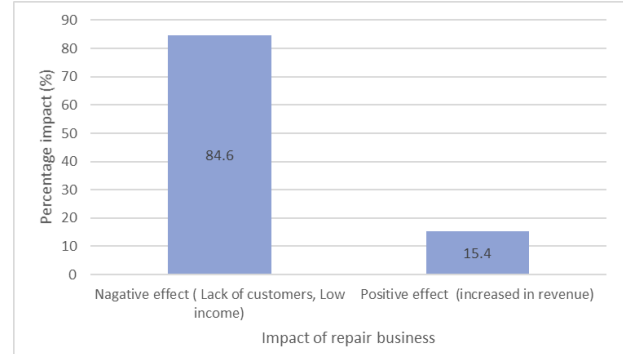


Figure 1 Impact of automobile technology on repair business

Figure 1 shows the results of impact of advanced automobile technology on the repair business of respondents. Majority of the respondents are affected negatively (84.6%) in a way that they are losing customers which is resulting in low income. However, there are a few respondents that are affected positively (15.4%) which have seen an increase in revenue. Based on this result, it could be concluded that advanced automobile technology posed a great challenge to the survival of repair business of informal automobile mechanics in Ho municipality.

Factors	Mean	Std. Deviation	Sum of Squares	df	Mean Square	F	P-value
Education	1.26	.509	6.445	1	6.445	40.164	0.00
Availability of modern tools	1.94	.242	3.329	1	3.329	36.107	0.00
Use of On-Board Diagnostic scan tool (OBD)	1.83	.378	1.354	1	1.354	35.538	0.00

Table IV One-way ANOVA results for business and factors affecting modern repair business

\*significant interval is set at (P<0.05)

The factors that affect the repair business of the respondents were examined using a linear regression one-way between groups ANOVA analysis, and the results are displayed in table IV. The results show that all the factors were statistically significant at p<0.00. It could be concluded that, low educational level, unavailability of modern diagnostic tools, and lack of knowledge on how to use OBD scan tools are factors contributing to the challenges facing informal automobile repair business in Ghana.

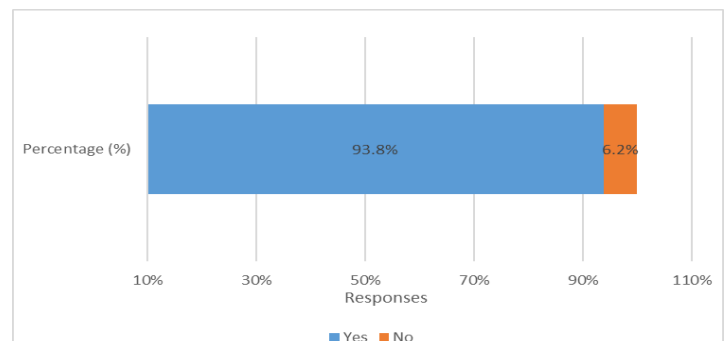


Figure 2 Respondents willing to learn OBD and modern repair techniques

In order to find out whether the respondents have accepted that introduction of advanced technology into modern automobile is gradually sending them out of business and are willing to update their knowledge on OBD systems and modern automobile technology, 93.8% of them expressed their willingness and readiness to learn (see Figure. 1). It could be concluded that, informal automobile mechanic in Ghana have accepted the fact that the times of being only mechanically inclined and not seeing the need for higher education as a prerequisite for automobile mechanic works in the automobile repair sector has passed.

### 3.2 Interview of vehicle owners on the topic of the study

According to [10] motor vehicles play a conspicuous role in the modern industrial economy and cars and light trucks offer rapid, reliable, and convenient mobility on demand to an ever-growing number of people in countries throughout the world. In this section the views of vehicle owners are presented on the effect of technology in modern vehicles on their transportation activities. The vehicle owners were confronted with three major questions. One; Have you ever repair your vehicle at local garage if yes, are informal automobile mechanics able to meet your expectations as far as repairing of your vehicle is concern? Two; do you think informal mechanics have the technical skills and knowledge enough to repair modern vehicles and finally what effect does this have on you as a person owning a modern vehicle and would you choose a dealership to repair your vehicle if that option was available?

All 86 modern vehicle owners (100%) agreed they have ever repaired their vehicles at local garages but indicated that informal automobile mechanics do not meet their expectations. When the vehicle owners were asked about the knowledge and skills of mechanics on modern vehicle technology, 90% of them stated:

*“that is the major problem with these mechanics, they don't have knowledge and technical skill and tools or machines to work on modern cars and always doing try-and-error until they finally render your vehicle immobile”* while the remaining 10% indicated that *“some have the skill and knowledge but don't have the machines and appropriate tools to work with”*.

Then when the vehicle owners were asked the effect this situation is having on them, they complained that:

*“we end up paying money for parts that are not damaged or defective which increases repair cost because wrong diagnoses are made by these mechanics and sometimes, we can't travel because the vehicles spend weeks with the mechanics”*

Finally, when vehicle owners were asked if they would choose a dealership garage to repair their vehicle if that option was available? All the 86 modern vehicle owners stated with interest they will choose dealership repair garages. This pose a great danger to the repair business of informal garages.

### 3.3 Discussions

Just as the auto industry is responsible for countless technological advances, the technology that goes into caring for cars and managing auto repair shops has likewise changed.

However, mechanics in micro and small enterprises face the challenge of servicing, diagnosing and repairing modern automobiles due to the dynamic technological innovations in the industry [15]. In this study we assessed the impact and knowledge of advanced automobile technology on repair business of informal automobile mechanics in Ghana. The result shows that advanced technology introduced into modern vehicle is affecting the repair business of respondents negatively (84.6%) than positively (15.4%). The results show that there was a positive correlation statistical significance between impact on repair business and other three independent variables. Education ( $P<0.00$ ), availability of modern diagnostic tools ( $p<0.00$ ) and capability to use OBD scan tool ( $p<0.00$ ) see table 4. The study revealed that knowledge on modern vehicle systems such as; engine management, anti-lock braking, cruise control, continuously variable transmissions were all statistically significant ( $p<0.00$ ) Table 3. Our study has supported findings of other studies into the repair business of informal automobile mechanics that revealed that low educational level, unavailability of modern diagnostic tools, lack of knowledge on modern vehicle technology and inability to acquire and use modern vehicle diagnostic equipment and tools are the factors contributing to challenges facing repair business of informal automobile mechanics in Ghana [1], [8]. This study has found low education level of respondents to be the main contributor to the challenges informal automobile mechanics faces today in the repair and service sector. It could be seen in Table 1 that majority of respondents have low education and that has affected their knowledge on modern vehicle technology, the equipment and tools required to repair and maintained it. This is because theory of automobile technology is not taught at junior high or middle schools but rather at senior high, technical/vocational, polytechnic and universities. A similar study conducted by [9] in Nigeria explain that this has caused a major setback in that most of the auto technicians are ignorant and not quite familiar with the advancing technological know-how of the trade. However, from the literature reviewed it is evident that knowledge and understanding of how modern vehicle work is important for effective and efficient repair work. [6] states that the knowledge needed for accurate diagnostics is based on understanding of the system in which the problem exists and having the ability to apply a logical diagnostic routine. According to [11] any work carried out by untrained personnel on vehicle with complex electronic system can result in unnecessary damage and expense. From Fig. 2 it is obvious the respondents have accepted that the introduction of advanced technology into modern vehicles requires higher education and are therefore willing to update their knowledge in order to remain in the repair business (93.8%). The interview with modern vehicle owners has also confirmed that for informal automobile mechanics to continue in business there is a need for them to update their knowledge because majority of the vehicle owners are willing to repair their vehicles at dealership garages should one be established in the city. If this happens, it could pose a serious further threat to the repair business of informal mechanics. According to [8]

the general engineering mechanic and roadside mechanics or diagnosticians must be able to understand and appreciate the use of technology as a business tool. It is critical for the informal auto mechanics to adopt and appreciate the advantages of modern automobile technology in order to alleviate the possible challenges [16] which we believe our respondents have now realized.

#### 4) CONCLUSION

This study assessed the knowledge and impact of advanced automobile technology on repair business of automobile mechanics in the informal sector in Ghana. The results revealed that it has become conspicuous to both informal automobile mechanics and vehicle owners that technology has changed and will continue to change the automotive system as far as emission regulations becomes more stringent. Therefore, a mechanic or automobile technician requires appropriate knowledge, skills, modern diagnostic tool and approach to effectively perform efficient repair work in order to stay in the automobile repair business. Most regional capital cities in Ghana are witnessing rapid urbanization which means that demand for transportation will increase and since Ghana is not a vehicle manufacturing country and road transport remain the dominant mode of transportation in the country, vehicle importation will continue with most likely to be used vehicles and the need of knowledgeable and skillful automobile mechanics to service these advanced-vehicles full of electronics will remain important for the foreseeable future.

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