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Impact Analysis on the Application of Contemporary Methods of Maintenance in the Nigeria Automotive Industry

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Authors' contributions

This work was carried out in collaboration between both authors. Author SOE designed the study. Author AOJ performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript, managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Modern automobiles are now embedded with a lot of sensors and actuators controlling several systems in the vehicle, thereby making it an electro-mechanical means of transportation rather than the mechanical means known some decades ago. Consequently, several automobile diagnostic tools have been made available to diagnose faults developed by these modern automobiles. This paper analyses the impacts of the contemporary diagnostic tools for automobile maintenance/repair in the Nigerian Automobile Industry. Benz, Toyota, Honda, Kia, and Nisan are the sample model used for the research; On Board Diagnostic (OBD II); Coolant Tester; Pressure Test Kit; Spark Checker Kit; Fuel Injection Pump Tester; Compression Tester; Mechanic's Stethoscope; Digital Multimeter, are the modern tools used for the study. In the study, various automobile repair and maintenance tools were investigated using a questionnaire administered to local and modern automobile repair garages. The impact of the modern automobile diagnostic tools on different car models, and different car systems has been studied. The study reveals that not all the modern tools are effective when used to diagnose faults. Fuel Injection Pump Tester is the most effective tool

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(with about 85% effectiveness), followed by Digital Multimeter (about 75% effectiveness), and OBD II (about 70% effectiveness). Compression Tester and Mechanic's Stethoscope are less effective (about 40%), and many auto-technicians do not make use of them. Ignition, Fuel and Transmission systems are mostly maintained with these modern tools. Though all the respondents are aware of the paradigm shift in the automobile industry, almost all of them (95%) consented that there is need for modern diagnostic tools, but only 75% make use of these modern diagnostic tools.

Keywords: Automobile maintenance; car models; impact analysis; modern diagnostic tools.

1. INTRODUCTION

There are newer and more efficient maintenance and repair diagnostic tools being introduced in automobile sector all over the world [1,2]. The effect, impact and role of modern automobile diagnostic tools are yet to be fully captured in the Nigerian auto-maintenance and repair setting. This paper assesses the impact of modern diagnostic tools on different car models and car systems; the level of expertise of auto-technicians with these tools, and the adaptation rate.

The specific objectives of the research are to identify the existing tools and to study the trend of application of these tools**;** to assess the impact of these tools vis-à-vis different car models and car systems, and expertise of auto-technicians. In almost all modern vehicles, computer is in charge of most systems, including the ignition system, the automatic transmission, the fuel injection, brake system, and many other smaller systems and parts [3]. Sensors throughout the car are constantly gathering and transmitting data back to the brain box; the main computer modules in the car. Technology in the automobile sector advances continually and technological advancement is at a very fast pace [4,5,6,7], and [8]. Most cars on our roads today are built with a lot of electronically controlled systems [9,10], and [11]. There are newer and more efficient maintenance and repair tools being introduced in the automobile sector all over the world. Diagnostic tools for car maintenance or repair can be categorised into two: those that can diagnose the entire faults in a car, and those with specific task. Example of the former is On Board Diagnostic (OBD), while Spark Checker Kit, Compression Tester, Digital Multimeter, and Fuel Injection Pump Tester are examples of tools with specific tasks. Related literatures include works on modern diagnostic approach for automobiles system condition monitoring, automotive electronics- opportunities and challenges for Nigeria's auto sector, microsystems assembly technology for the 21st Century, advanced automotive fault diagnosis [12-16].

Other literatures captured studies on the changes in modern vehicle technologies; their challenges associated with repairs and possible opportunities available to roadside mechanics; the problems facing auto technicians with a view to optimizing auto repair work; the modern automobile vehicle repair and maintenance practises in the micro, small and medium scale garages [17-20]. Some of these literatures focused on the literacy of auto-technicians, years of experience, and methods of vehicles faults diagnose by local garages, whether modern vehicle pose a challenge in terms of repair, and whether or not technicians use scan tools to diagnose car faults. In all of the literatures reviewed, an attempt was made to analyse the impact of only one of the modern diagnostic tools- the OBD II.

2. DATA COLLECTION METHOD

For data collection, survey research method was used [21,22,23]. Field survey, interview with auto-technicians; both local and modern workshops in Lagos and Ibadan, are the methodology employed in this study. The questionnaires were administered in Lagos and Ibadan because they are urban areas with higher number of workshops (garages); hence, it was taught that the views of the respondents from these areas would adequately represent the whole population. Systematic questions were asked in order to know the impact of the new diagnostic tools for automobiles maintenance/ repair on different car models, and car systems respectively. Furthermore, applicability of these diagnostic tools on car faults, rate of adaptability of apprentices, and customers reactions are some of the question asked. Twenty open-ended questionnaires were administered to auto technicians in Lagos and in Ibadan. Some of the workshops that use modern diagnostic tools only specialise in a particular car model, and this would limit the scope on the usage of modern diagnostic tools on different car models. Hence, limited numbers of workshops that specialise in at least five models were used for the study. The

questions sought to know the view of respondents (automobile technicians) about the effectiveness of modern diagnostic tools on different car models. A section tried to know the existing tools in different workshops, how often are the tools used, and to ascertain the readiness of the usage of modern tools by local technicians (roadside mechanics). In another section, questions were asked to know how applicable these modern tools are, how fast, and the reaction of customers to their usage in diagnosing faults. The final section sought to find out the effectiveness of these modern diagnostic tools on different car models, and how appropriate they are in resolving car system's faults. The last four questions in this section sought to know if these workshops involve in training and retraining, and the rate of adaptability of apprentices to these modern tools.

Observations and discussions were also used to some extent in gathering the relevant data. During the survey exercise, it was discovered that even the technicians that still make use of archaic tools or method for troubleshooting automobile (road side mechanic) employ the use of modern diagnostic tool.

3. RESULTS AND DISCUSSION

This section discusses the outcome of the research carried out in all the workshops, both in Lagos and Oyo states of Nigeria. Systematic analyses of all the car models and car systems are explained accordingly.

3.1 Impact Analysis of Modern Diagnostic Tools on Different Car Models

This section presents, interprets and analyses the data generated from the study in relation to different car models. The section starts by analysing the impact of the new diagnostic tools on different car models like Benz, Toyota, Honda, Kia, and Nisan; considering the fact that these models are the most common in Nigeria. The effect of each of these tools on each car model is carefully outlined in Figs. 1-5.

Fig. 1 shows the effect of different diagnostic tools on Benz model. Only 30% of the respondents affirmed that OBD is effective on Benz while one-fifth (20%) said it is very effective. Others (20% each) have different views ranging from its ineffectiveness and non-applicability of OBD on Benz model. FIPT (Fuel Injection PUMP Tester) is the most effective diagnostic tools on Benz; half of the respondents affirmed that the tool is effective. 20% of the respondents shared the same view on the effectiveness of Coolant Tester (CT) and Spark Checker Kit (SCK) on Benz model while these tools are not applicable to half of the respondents. More than half (70%) of the respondents do not use Compression Tester on Benz model, while only 30% said the tool is effective.

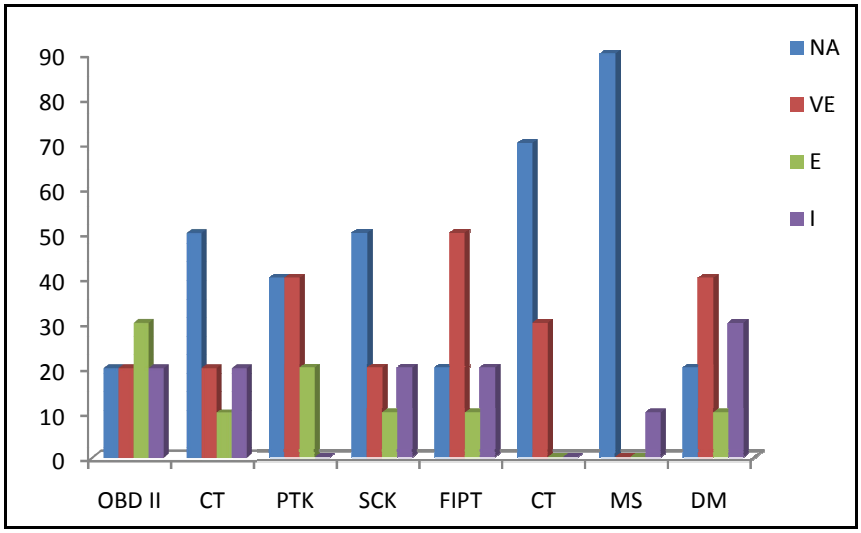

Fig. 1. Effect of modern diagnostic tools on Benz model

NA: Not Applicable; VE: Very Effective; E: Effective; I: Ineffective

OBD II: On Board Diagnostic II; CT: Coolant Tester; PTK: Pressure Test Kit; SCK: Spark Checker Kit; FIPT: Fuel Injection Pump Tester; CT: Compression Tester; MS: Mechanic's Stethoscope; DM: Digital Multimeter

From Fig. 2, it can be seen that all the respondents (100%) affirmed that the use of OBD on Toyota is very effective. 100% 0f the respondents also said that FIPT works very effectively on Toyota model. Two-fifth (40%) of the respondents put forward the non-applicability of CT while equal percentage (40%) said that the tool (Coolant Tester) is very effective. Half of the respondents posited that PTK and CT (Compression Tester) are very effective when used to diagnose Toyota model while only 10% of the respondents said PTK is very ineffective. Almost all (90%) the respondents affirmed that DM is very effective as a diagnostic tool on Toyota.

Fig. 3 shows that half of the respondents claimed that the use of OBD is very effective on Honda while almost one-third (30%) affirm the effectiveness of OBD on Honda car model. Furthermore, the study revealed that the use of CT is not in vogue as supported by exactly half of the respondents while 40% stated otherwise by responding that its use is very effective. Moreover, investigation revealed that SCK is not much in use on Honda car model because half of the respondents claimed such. Nevertheless, 40% of them still claimed that SCK is very effective on Honda car model. The findings clearly show that majority (80%) of the respondents affirmed that FIPT is very effective while infinitesimal number (20%) of them stated that it is not in use on Honda car model. The use of DM, as claimed by the respondents (70%), is very effective while one-fifth (20%) said DM is not in use on Honda car model.

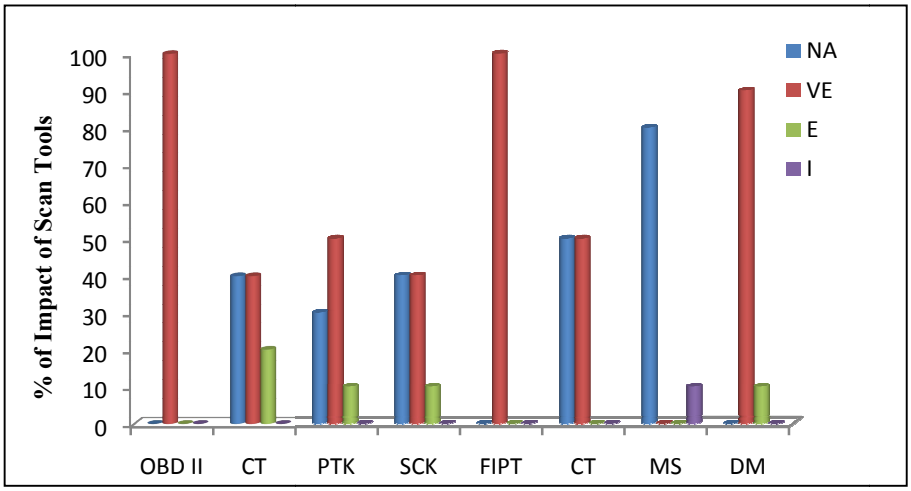

Fig. 2. Effect of modern diagnostic tools on Toyota model

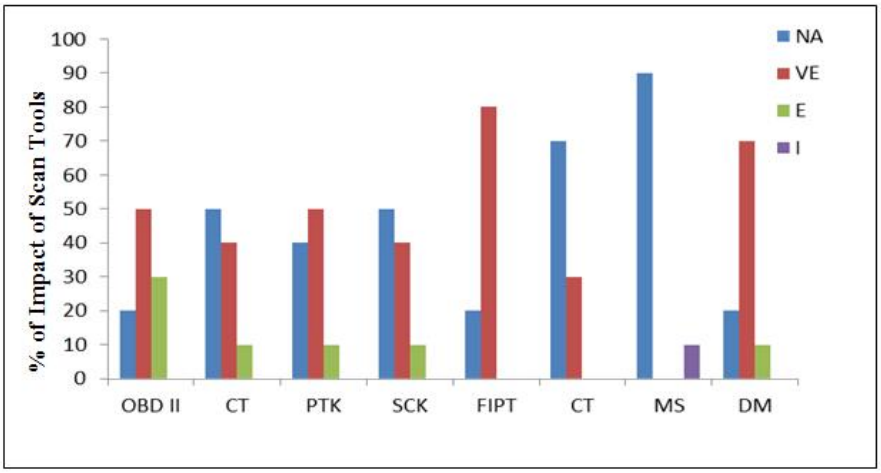

Fig. 3. Effect of modern diagnostic tools on Honda model

Fig. 4 reveals that half of the respondents claimed that the use of OBD is effective when used to diagnose Nisan model while almost one-third (30%) affirmed that it is very effective. Also, equal percentage (50%) affirmed that CT and SCK are not applicable on Nisan, whereas 40% claimed that these tools are very effective when used to diagnose Nisan model.

While responding to the effectiveness of PTK on Nisan car model, exactly half of the respondents affirmed that the tool is very effective and two-fifth (40%) of them claimed that PTK is not applicable to Nisan. The respondents shared their views equally (70% each) by affirming that FIPT and DM are very effective on Nisan. Furthermore, the investigation revealed that the use of Compression Tester is not in vogue as supported by more than half of the respondents (70%) while 30% stated otherwise by responding that its use is very effective. In Fig. 5, more than half (60%) of the respondents claimed that the use of OBD on Kia model is very effective while only one-fifth (20%) said the tool is just effective when used to diagnose Kia model. More than half (60%) of the respondents do not make use of CT as a diagnostic tool while only small percentage (30%) said the tool is very effective. Majority (80%) of the respondents stated that FIPT is a very tool on Kia. These same respondents have the same view on DM tool when 70% of them posited that the tool is very effective on Kia while only 10% said it is effective.

3.2 Impact Analysis of Modern Diagnostic Tools n Different Car Systems

This section investigates the analyses of the appropriateness of modern diagnostic tools on car systems like ignition system, fuel system, brake system, transmission system, and etcetera [24-29]. It finally assessed the percentage of local workshops that use the modern tools, adaptability rate of apprentices, and training and retraining of apprentices.

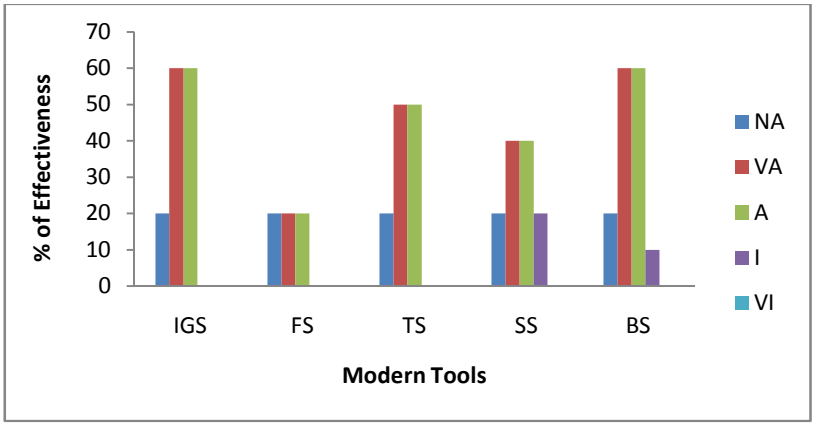

Fig. 4. Effect of modern diagnostic tools on Nisan model

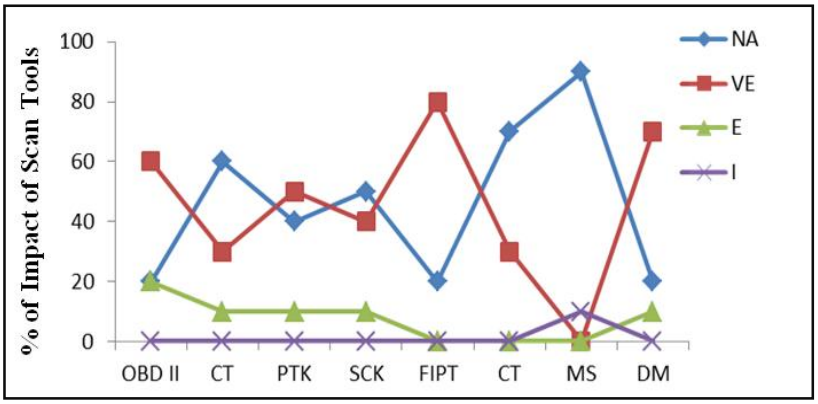

Fig. 5. Effect of modern diagnostic tools on Kia model

3.2.1 Impact analysis of modern diagnostic tools on different car systems of Benz model

Fig. 6 shows that only 30% of the respondents agreed that the ignition system (IGS) of Benz model can be easily diagnose appropriately using modern tools, and one-tenth (10%) of the respondents said modern tools is very inappropriate for diagnosing IGS of Benz. Evaluating the appropriateness of these tools on the fuel system (FS) of Benz, 30% of the respondents posited that the tools are very appropriate while one-fifth (20%) acclaimed that the tools are appropriate. However, 20% stated that the tools are very inappropriate for fault diagnose. Only one-fifth (20%) of the total respondents affirmed that the tools are very appropriate on steering system (SS) of Benz while 10% said it is appropriate.

3.2.2 Impact analysis of modern diagnostic tools on different car systems of Toyota model

From Fig. 7, more than half (70% each) of the respondents shared equal views, affirming that modern tools on IGS and FS of Toyota model are very appropriate while the remaining 30% said the tools are appropriate on this car model. However, two-fifth (40%) of the respondents posited that these modern tools are very appropriate in diagnosing faults on the SS of Toyota model while others shared equal views (30% each), affirming that the tools are appropriate and inappropriate respectively.

On BS of Toyota model, 40% of the respondents acclaimed that the tools are appropriate while the other respondents (30% each) equally acclaimed that the modern tools are very appropriate and inappropriate respectively.

3.2.3 Impact analysis of modern diagnostic tools on different car systems of Honda model

In Fig. 8, half of the respondents stated that the modern tools are very acceptable (very appropriate) for diagnosing the IGS of Honda model while only 30% said that the tools are appropriate. One-fifth (20%) of the total respondents were indifferent about the acceptability of modern tools on Honda IGS. More than half (60%) of the respondents posited that the use of modern tools on fuel system (FS) of Honda is very appropriate while only one-fifth (20%) claimed that it is just appropriate. Three-fifth (60%) of the respondents stated that modern tools are appropriate in diagnosing the TS of Honda while 20% said the tools are very appropriate. Larger percentage (40%) stated that the modern tools are inappropriate on the steering system of Honda. Whereas while responding to the appropriateness of these tools on BS, 30% affirmed that the tools are very appropriate. Only one-fifth posited that the tools are not suitable for the brake system of Honda model.

3.2.4 Impact analysis of modern diagnostic tools on different car systems of Kia model

Fig. 9 further shows that almost two-third (60%) of the respondents claimed that modern tools are appropriate to diagnose the ignition system of Kia models while only 20% posited that tools are

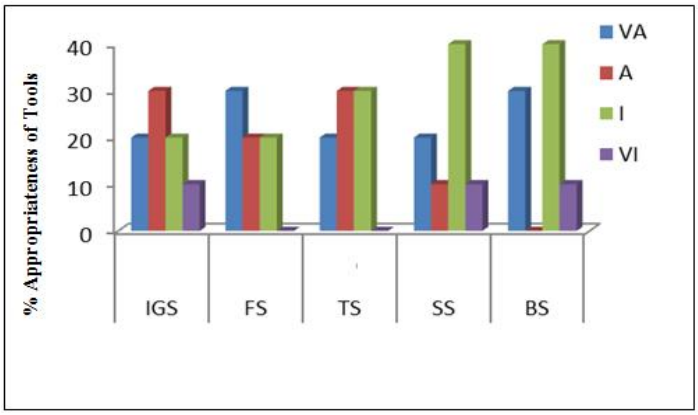

Fig. 6. Appropiateness of automobile diagnostic tools on Benz car systems

Note: IGS= Ignition System; FS= Fuel System; TS= Transmission System; SS= Steering System; BS= Brake System; NA= Not Applicable; VA= Very appropriate; A= Appropriate; I= Inappropriate; VI= Very Inappropriate

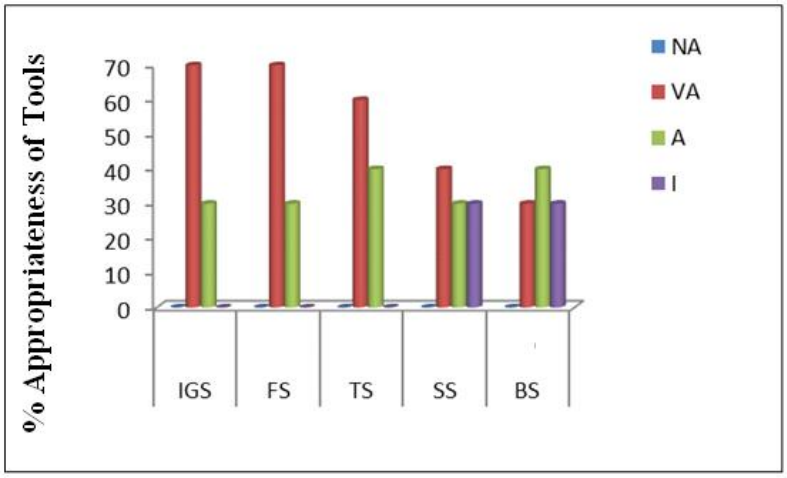

Fig. 7. Appropiateness of automobile diagnostic tools on toyota car systems

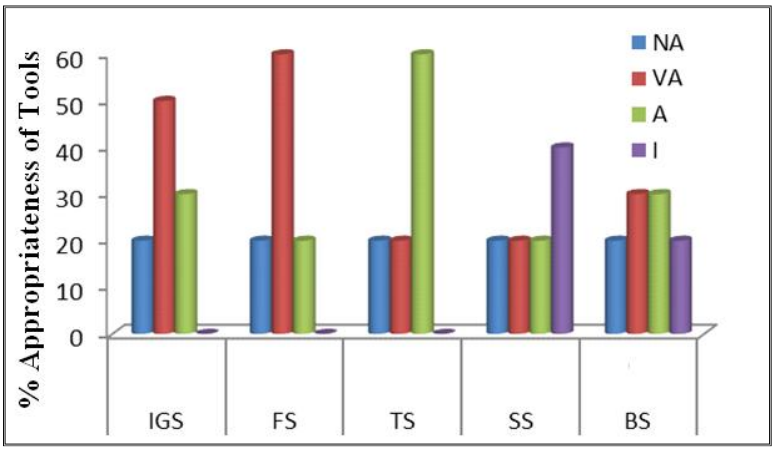

Fig. 8. Appropiateness of automobile diagnostic tools on honda car systems

very appropriate. Half of the respondents put forward the appropriateness of modern tools on the transmission system (TS) of Kia while almost two-third (30%) said the tools are very appropriate.

Two-fifth (40%) of the respondents affirmed that the SS can be properly diagnose using these modern tools while others shared their views equally (20% each) by stating that tools are very appropriate and inappropriate respectively. Responding to the appropriateness of these modern tools on the brake system (BS) of Kia model, more than half (60%) of the respondents stated that the tools are suitable to diagnose brake faults on Kia model. Meanwhile, 10% of the respondents said the tools are very appropriate to diagnose brake faults, another 10% said it is inappropriate.

3.2.5 Impact analysis of modern diagnostic tools on different car systems of Nisan model

In Fig. 10 exactly half of the respondents claimed that the fuel system (FS) is very appropriate, and can be properly diagnose using these modern diagnostic tools while only 30% posited that it is appropriate. Evaluating the appropriateness of these tools on the transmission system (TS) of Nisan, 30% of the respondents posited that the tools are very appropriate while another 30% acclaimed that the tools are appropriate. Examining the brake system (BS) of Nisan with these tools, exactly half (50%) of the respondents affirmed that the tools are very appropriate for diagnosing the brake system, and 10% of the respondents put forward the appropriateness of these tools. Only 20% acclaimed that the tools are inappropriate.

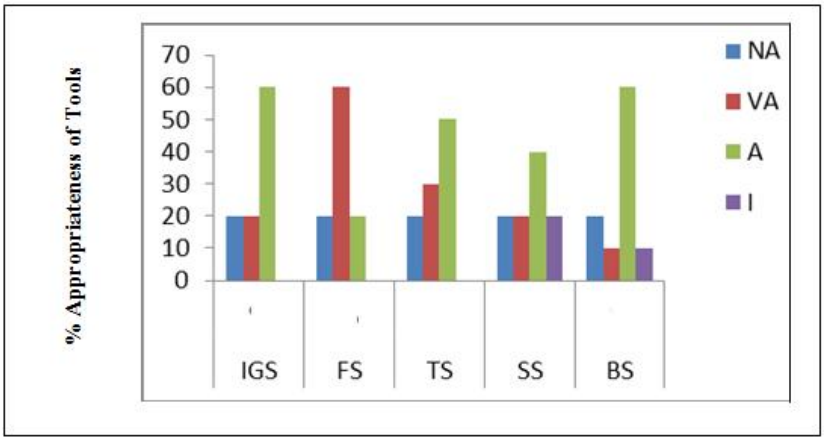

Fig. 9. Appropiateness of automobile diagnostic tools on kia car systems

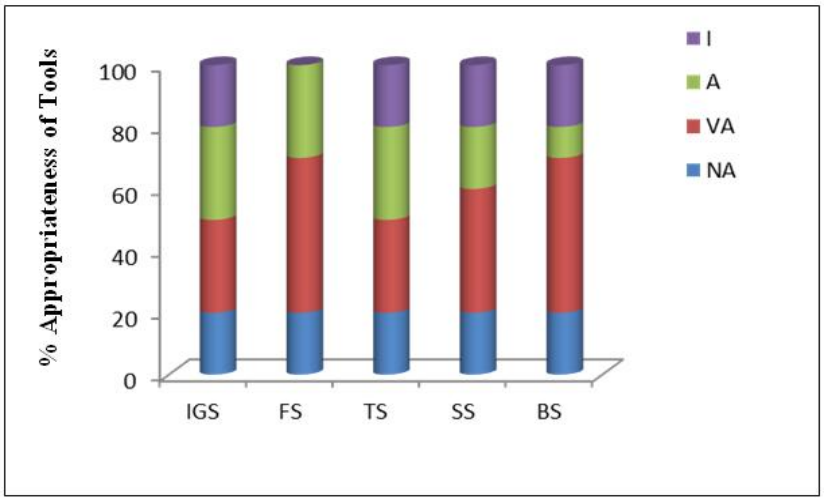

Fig. 10. Appropiateness of automobile diagnostic tools on nisan car systems

3.3 Need for Modern Diagnostic Tool

The research findings revealed that 95% of all respondents (both local and modern workshops) are aware of the paradigm shift in automobile industry; they are well informed that automobiles are moving from being a mechanical means of transportation to electro mechanically operated system.

3.4 Workshops With and Without Modern Diagnostic Tools

Research findings shows that exactly 50% of the local workshop technicians (road side mechanics) make use of some of these modern tools to diagnose car faults. A result that contradicts the report of Isaac Edunyah about the research conducted in Ghana on the Technology and Modern Automobile Industry- Challenges and Opportunities for Roadside Mechanics in Ghana. He stated that 88% of his respondents (roadside mechanics) did not have the scan tool to troubleshoot and diagnose fault on the modern vehicles and still use the try-and –error method of repairing. This shows that the awareness of modern automobile diagnostic tools is more prevalent in Nigeria.

3.5 Applicability of Modern Diagnostic Tools

In Fig. 11, when respondents were asked whether these modern diagnostic tools are applicable to solving all car faults, more than half (55%) of the respondents opined contrary.

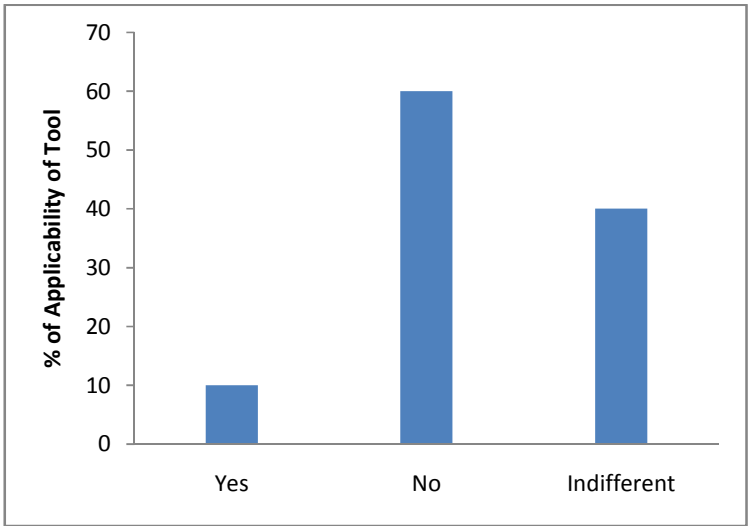

Fig. 11. Applicability of modern diagnostic tools

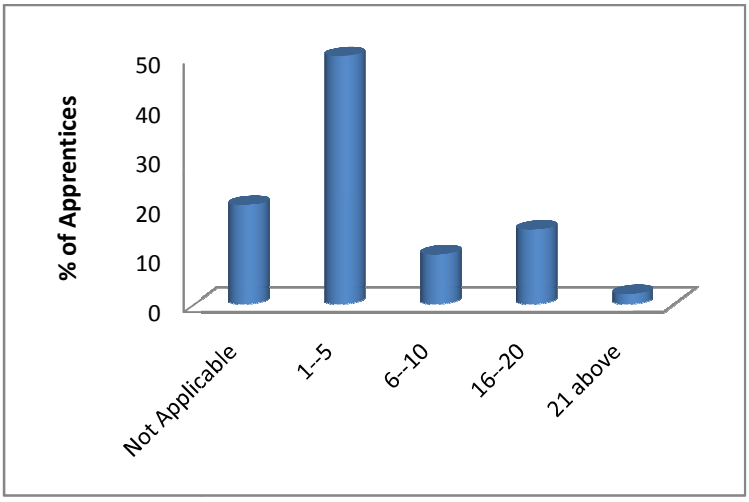

Fig. 12. Apprentices involved in workshops

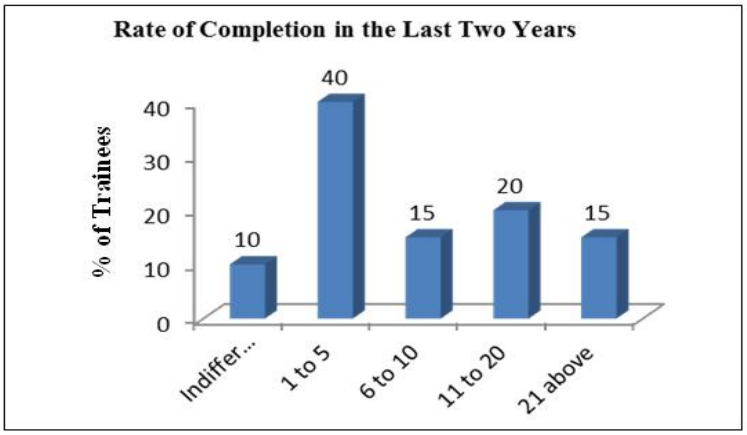

Fig. 13. Completion of training by auto-mechanics

3.6 Number of Apprentice(s)

Though almost all (95%) of the respondents involve in training and retraining, only 5% has apprentices within the range of 21 and above, while sizeable number (50%) only have trainees of less than five people as shown in Fig. 12.

Obviously as the vehicle becomes more sophisticated with electro-mechanical devices, this less number of trainees will not bridge the gap of technical-know-how in modern automobiles.

3.7 Completion Rate of Apprentice(s) in the Last Two Years

Fig. 13 clearly shows the number of apprentices that completed their period of training in the last two years. 0nly 40% with apprentices not more than five have completed his training. This further shows the low level of trainees.

4. CONCLUSION

The objective of the research is to assess the impact of modern diagnostic tools on different car models; the level of expertise of auto-technicians with these tools, and the adaptation rate. Some facts can be drawn on the suitability of modern diagnostic tools on modern car models. It can be clearly seen that certain modern tools are very effective, effective and ineffective on some car models relative to others; while some tools are very effective during diagnostic test, respondents are indifferent about some other tools due to their ineffectiveness. Hence, car manufacturers should take into cognisance the appropriate tools that would be suitable for their models when diagnosing it. Fuel Injection Pump Tester is the most effective tool because it works perfectly on all the sample car models, followed by Digital Multimeter, then On-Board Diagnostic tool (OBD II). Other diagnostics tools are averagely effective on some car models, while some are less effective.

Examining the response of respondents on car systems of the models used, it was discovered that modern diagnostic tools can resolve issues on ignition and fuel systems faster than on steering and braking system. So, car manufacturers are further charged to work toward improved design on the existing design for proper diagnose of faults. More than half of the respondents even claimed that the modern diagnostic tools do not solve all faults of modern automobiles.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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