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IMPACT OF MODERN WORKSHOP PRACTICES ON PRODUCTIVITY OF AUTOMOBILE REPAIR WORKSHOPS

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Abstract

This study investigated the impact of modern workshop practices on the productivity of automobile repair workshops in Abuja Municipal Area Council, the Federal Capital of Nigeria. The objectives of this study were to assess the extent of adoption of modern workshop practices and ascertain the level of productivity in selected automobile workshops. A survey research design was employed that utilized personal observations, questionnaires, and interviews to collect data from 15 MAWs and 15 RSM workshops. The findings revealed significant disparities in equipment availability and diagnostic capabilities between MAWs and RSM workshops. Results from the study indicated that 80 % of the MAWs have emission testing equipment, whereas the entire RSM automobile workshops under study did not have the equipment. The outcome of checks on the availability of ADAS calibration tools revealed that 73.3 % of the MAWs were adequately equipped with the ADAS tools, while 26.7 % were not. However, the checks on the RSM automobile workshops under study indicated that only 7.5 % of the workshops have the ADAS calibration tools. Additionally, MAWs exhibited superior productivity metrics than the RSM workshops, which included first-time fix rate (70.3 % vs. 29.7 %), rework rate (8.2 % vs. 91.8 %), and customer satisfaction index (68 % vs. 32 %). The findings have significant implications for policy makers and workshop owners on the need for standardized training of mechanics and equipment upgrading to enhance the Nigerian automotive repair industry's productivity and competitiveness.

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1.0 Introduction

Ziblim et al., (2018) noted that traditional automobile workshop practices in Nigeria have been characterized by informal setups, often referred to as roadside mechanics. These mechanics, while possessing practical skills in assembling parts, often lack the diagnostic abilities and knowledge required to handle modern vehicles equipped with advanced technologies (Wordu, 2021). Moreover, the absence of standardized training and regulatory oversight in these informal workshops has led to deficiencies in safety measures and environmental practices. In contrast, modern automobile workshop practices emphasize the use of sophisticated tools and technologies for diagnostics, repair, and maintenance.

Computerized diagnostic systems, sensor technologies, and specialized software play a crucial role in identifying and addressing issues in modern vehicles (Adeniran et al., 2024). Despite the rapid advancements in automotive technology and the global adoption of modern workshop practices, the Nigerian automobile repair sector continues to face significant challenges in keeping pace with these developments (Kanife et al., 2022).

While the demand for maintenance and repair services remains high, particularly in urban centers like Abuja, various factors hinder the effectiveness and efficiency of automobile workshops in meeting these demands. Notable gaps exist between the technological capabilities of modern vehicles and the resources available in many automobile workshops in Nigeria. Olaitan and Benjamin (2020) noted that traditional roadside mechanics often lack access to sophisticated diagnostic tools, computerized systems, and specialized software required to effectively diagnose and repair modern vehicles equipped with advanced technologies.

Advancements in workshop technologies, such as scanning devices that are connected to the On-Board Diagnostics (OBD) system, have significantly enhanced the efficiency and accuracy of automobile repair and maintenance. These tools streamline diagnostics in modern workshops by providing real-time data from vehicles, enabling technicians to quickly identify issues and implement solutions. This technological integration contrasts with traditional methods, where mechanics often rely on manual inspection and experience, leading to longer repair times and potential inaccuracies. By adopting such modern practices, workshops can improve productivity, reduce labor costs, and enhance customer satisfaction, demonstrating the critical role of technology in the evolving automotive service industry.

The advancement in automobile workshop practices is expected to coincide with the rapid advancement in the manufacturing sector to meet the latest demand (Ziblim et al., 2018; Akuh and Kwabena, 2019). Modern car repair and diagnostics rely on various software tools and technologies to efficiently diagnose and fix issues. Olaitan and Benjamin (2020) noted that the use of computers in modern automobile practices to access some sensors and actuators connected to the vehicle's Onboard Diagnostics systems (OBD) is now a breakthrough in modern vehicle maintenance practices.

Akuh and Kwabena (2019) conducted a study that focused on the impact of advanced automobile technology on informal automobile mechanics and their repair businesses. Their findings highlighted that the introduction of advanced technology had a predominantly negative impact on informal repair garages, with 84.6% of respondents reporting adverse effects. These effects included a gradual displacement of informal mechanics from the business due to technological advancements. The study also established a positive correlation between knowledge of advanced technology and its impact on the repair business, underscoring the importance of education and competency-based programs to support local repair workers.

Meanwhile, Adeniran et al., (2024) conducted a study that focused on the technical competencies necessary for automobile mechanical apprentices to successfully transition into skilled artisans capable of establishing quality mechanic firms in Akure, Ondo state, Nigeria. Notably, their findings highlighted the increasing significance of modern automotive diagnostic tools in enhancing the operational efficiency of contemporary mechanic firms.

The target area selected for the investigation was Abuja Municipal Area Council (AMAC) in Nigeria. Thus, 15 modern automobile workshops and 15 roadside mechanics in AMAC were visited, and a checklist was developed in line with International Standard Organization (ISO) recommendations for automobile workshops. The availability of modern tools through professional observation was used to generate results. However, the research did not cover investment capital for setting up a workshop, work pricing, and workshop profitability.

Mahamid (2020) emphasized that productivity is crucial in the service industry, particularly in automobile workshops, where efficient service delivery directly impacts customer satisfaction and loyalty. Automobile workshops face unique challenges, such as complex repair tasks, high customer expectations, and intense competition. Thus, to remain competitive, workshops must optimize productivity, ensuring timely and effective service delivery. In automobile workshops, productivity measures the efficiency of technicians, equipment, and processes. Arashpour et al., (2013) noted that equipment quality and maintenance are some factors affecting productivity.

2.0 Methodology

2.1 Method and Technique

A prepared checklist was used to record the activities in selected automobile workshops. The items on the checklist include the availability of office facilities and modern automobile repair equipment. Interviews and observations during physical visits to Modern Automobile Workshops and Roadside Mechanics were employed in this study. Meanwhile, cluster sampling technique was chosen for data collection, and the sample size considered was 15 for each cluster. Customer responses to ascertain their level of satisfaction were obtained through questionnaires.

Figure 1. Reception at Luftreiber Automobile Center Jahi, Abuja, Nigeria.

Every modern automobile workshop is expected to have an office space for both customers and key organizational heads. Figure 1 shows the reception office at Luftreiber Automobile Center Jahi, Abuja, Nigeria.

Onboard diagnostic scanners enhance diagnostic accuracy, reduce repair time, and minimize errors. These devices enable mechanics to efficiently identify and address issues in vehicles. It improves workflow and productivity. Their integration reflects the shift toward technology-driven practices, ensuring that workshops meet the demands of advanced automotive systems. Figure 2 shows the OBD scanners used in one of the modern automobile workshops.

Figure 2. The OBD Scanner Technician Explains their Functions.

Figure 3. 3D Wheel Alignment Equipment at Nut and Bolt Jahi, Abuja, Nigeria.

The 3D wheel alignment is a cutting-edge technique that uses high-resolution cameras and precise sensors to measure and adjust vehicle wheel angles. It ensures optimal tire performance and lifespan. This technology accelerates alignment processes, minimizes errors, and contributes to the productivity of modern workshops by achieving a high TCR. Figure 3 shows a technician explaining the 3D wheel alignment procedure at the Nut and Bolt Auto Services Jahi, Abuja, Nigeria.

Figure 4. Diagnostic Equipment at Taharish Automobile Service, Jahi, Abuja, Nigeria

Diagnostic software and programs are indispensable tools in automobile workshops. These enable mechanics to efficiently identify, analyze, and resolve complex vehicle issues by interfacing with vehicle onboard computers to retrieve sources of error signals, which hitherto could not easily and quickly be identified. Figure 4 shows the different diagnostic equipment at Taharish Automobile Service Jahi, Abuja, Nigeria.

Figure 5. Battery Charging Machine at Nut and Bolt Jahi, Abuja, Nigeria

A battery charging machine is an essential tool in modern workshops. It is used to maintain and restore the vehicle battery performance. Battery charging machines also provide controlled charging to prevent overcharging and ensure battery longevity. Figure 5 shows the battery charging machine at Nut and Bolt Jahi, Abuja, Nigeria.

In contrast, traditional roadside mechanic workshops lack modern automobile repair equipment and test tools. The mechanics in these workshops rely on experience gained over time, regardless of whether such knowledge is based on any fundamental engineering principles. The consequences of this include premature breakdown of vehicles after repairs, reduced vehicle lifespan, avoidable accidents, and unexplained engine knock. Figures 6 and 7 outline some traditional roadside mechanics workshops.

Figure 6. Oluwa Auto Workshop at Gudu, Abuja, Nigeria.

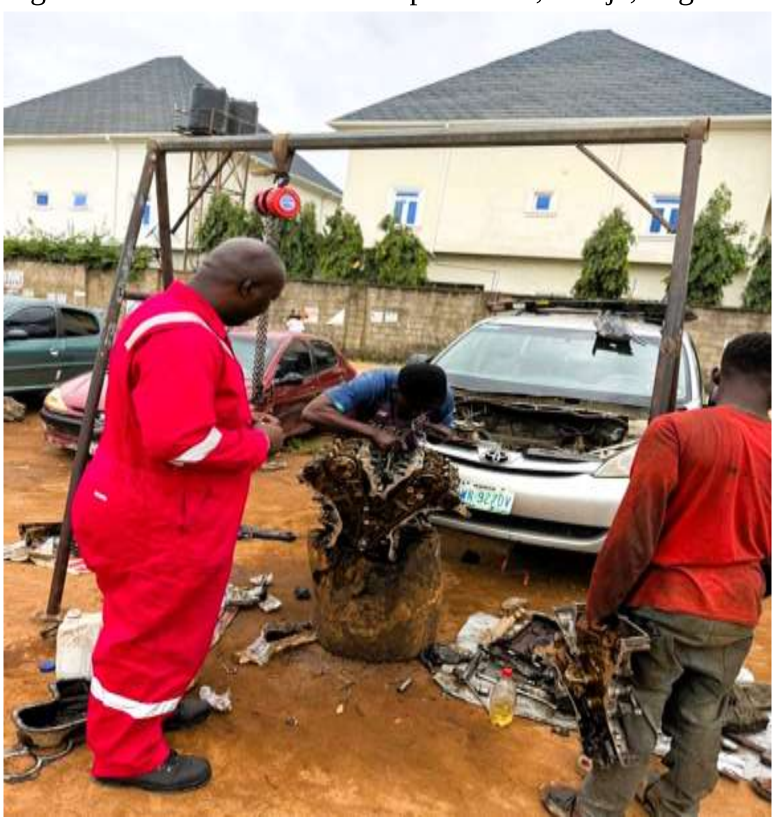

Figure 7. Hassan Gambo Mechanical Workshop, Abuja, Nigeria.

However, despite the above-mentioned consequences, traditional roadside automobile workshops are highly patronized by individuals from low income to very rich automobile owners. Figure 8 shows expensive cars brought to Shedrack J Mechanic Workshop for repair.

Figure 8. Shedrack J Mechanic Workshop.

2.2 Productivity Metrics

<u>First Time Fix Rate.</u>

First-Time Fix Rate (FTFR) is a vital metric in field service management that measures the percentage of service requests that are resolved on the first visit. The total number of service requests resolved on the first visit is divided by the total number of service requests resolved (Dutta, 2024; Limble CMMS, 2024). This metric provides valuable insights into technician expertise, service quality, and operational efficiency.

$$FTFR = \frac{FFIV}{FIV} \times \frac{100}{1} \quad \text{.................................. (Equation 1)}$$

Where:

FTFR = first-time fix rate

FFIV = Success Fix at the Initial Visit

FIV = total first initial visit

<u>Rework Rate.</u>

According to Oyewobi et al., (2011), Rework Rate (RR) is the process when the completed work does not conform to specifications. Thus, Mahamid (2020) noted that rework causes cost overrun, schedule delay, and customer dissatisfaction. Factors contributing to rework include technician errors, inadequate training, poor communication, and inefficient processes. The consequences of rework include increased costs, delayed project completion, and decreased customer satisfaction.

$$RR = \frac{BIR}{FIV} \times \frac{100}{1} \quad \text{....................................... (Equation 2)}$$

Where:

RR = rework rate

BIR = brought in for rework

FIV = first initial visit

<u>Task Completion Rate.</u>

Task Completion Rate (TCR) is a measure of tasks that were completed without critical errors, and the outputs of the task were correct; modified from Phoenix Strategy Group (2015).

TRC = $\left(100 - \frac{TTC}{TRC}\right) \times \frac{100}{1}$ ……………………… (Equation 3)

Where:

TCR = task completion rate

TTC = time taken to complete a task

TRC = time required to complete a task

<u>Customer Satisfaction Index.</u>

Customer satisfaction represents a measure of company performance according to customer needs (Hill et al., 2003); therefore, Eboli and Mazzulla (2009) noted that the measure of customer satisfaction provides a service quality measure. Customers express their points of view about the services by providing judgments on some service aspects through ad hoc experimental sample surveys, known as "customer satisfaction surveys." Thus;

CSI = $\frac{SC}{TC} \times \frac{100}{1}$ ………………………………… (Equation 4)

Where:

CSI = Customer Satisfaction Index

SC = satisfied customers

TC = total customers

Automobile workshop productivity is vital for delivering efficient service, ensuring customer satisfaction, and promoting customer loyalty.

<u>Repair Cycle Time.</u>

This is used to evaluate productivity in terms of the time taken for repairs; from Drop Off Time (DOT) to Pick-Up Time (PUT) of the automobiles (Thandi, 2023). This is measured in time duration and is expected to be low.

RCT = DOT - PUT ……………………………. (Equation 5)

Where:

RCT = repair cycle time

DOT = drop-off time

PUT = Pick-up time

3.0 Results and Discussion

3.1 Office Facilities and Modern Automobile Repair Equipment

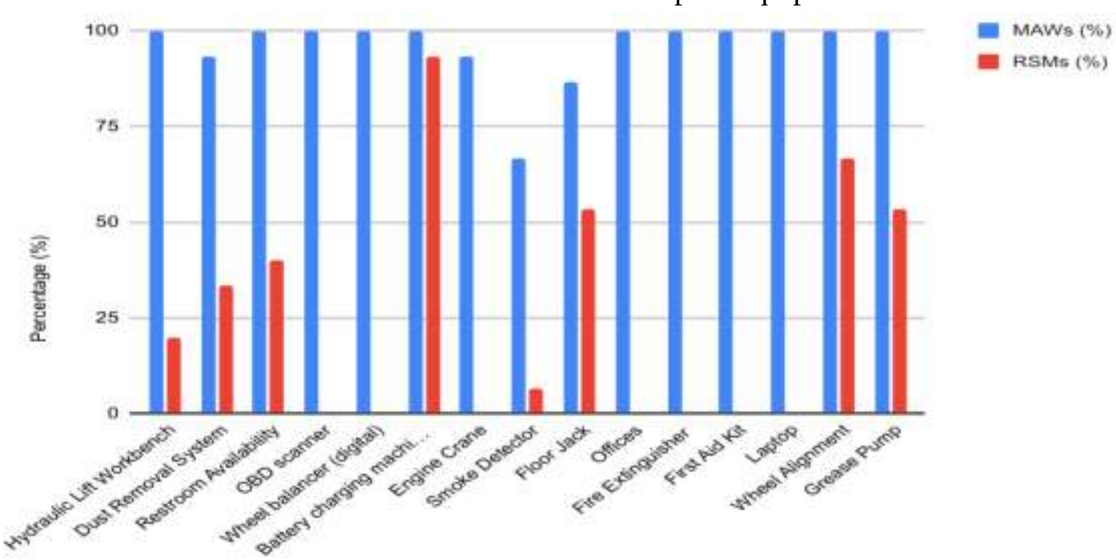

Figure 9. Comparison of Facilities and Modern Equipment in the MAW and RSM.

Figure 9 shows a comparison of the availability of facilities and modern equipment in MAW and RSM workshops. No RSM workshop has an office for administrative and marketing purposes. However, all modern automobile workshops (MAWs) have offices for administrative and marketing purposes. Similarly, all MAWs (100%) have restrooms for both staff and customers, whereas only 40 % of the RSM workshops have restrooms.

Most customers would like to be welcomed at a reception where they can discuss the faults observed in their cars. In addition, they may request the use of a rest room either before or after the discussions, and its lack of availability could be a negative aspect of the workshop. Furthermore, if rest rooms are not available for the workshop's staff, they would have to leave the premises to ease themselves. Some staff can use that opportunity to malinger, and the time spent during this period would definitely affect their daily output.

The figure also indicates that none of the RSM workshops have diagnostics OBD scanner and computers, a digital wheel balancing machine, and motorized engine crane, while these maintenance/repairs equipment were available in all the MAWs. In addition, grease gun pumps, wheel alignment sets, floor jacks, and battery charging machines were available in all the MAWs. However, only battery charging machines were available in more than 75 % of the RSM workshops.

Currently, most vehicles are manufactured with OBD ports in which the scanners can be connected for easy vehicle fault diagnosis. This vitiates the need for guess work and ultimately wrong diagnoses, the results of which could lead to unimaginable damage to the vehicles.

Figure 10 shows the availability of diagnostic hardware in the MAWs and RSM workshops. In addition to the diagnostic OBD scanners, all MAWs have code reader scanners, whereas none of the RSM workshops have such equipment. Similarly, all MAWs have fuel injection calibration equipment, and only one RSM workshop has it. Regarding the availability of multimeters and oscilloscopes, test tools were available in 93.3 % of the MAWs. Conversely, results from checks on the RSM automobile workshops indicated that only about 8 % of the workshops were equipped with multimeters and oscilloscopes.

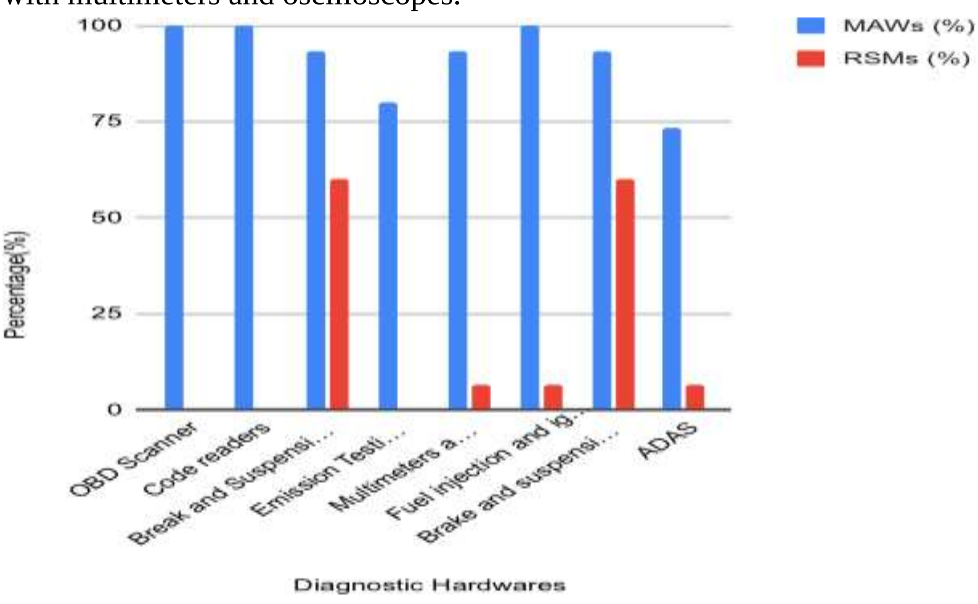

Figure 10. Availability of diagnostic hardware in MAWs and RSM workshops.

The exhaust gas analyzer (emission test equipment) is an essential tool for measuring and monitoring the products of combustion processes from engines. The results from the study, as shown in Figure 10, indicated that 80 % of the MAWs had emission testing equipment, whereas the entire RSM automobile workshops under study did not have the equipment. The outcome of checks on the availability of ADAS calibration tools revealed that 73.3 % of the MAWs were adequately equipped with the ADAS tools, while 26.7 % were not. However, checks on the RSM automobile workshops selected for the study indicated that only 7.5 % of the workshops had the ADAS calibration tools.

3.2 Productivity Metrics

Figure 11 shows values of the First Time Fix Rate (FTFR) for the selected MAWs and RSMs.

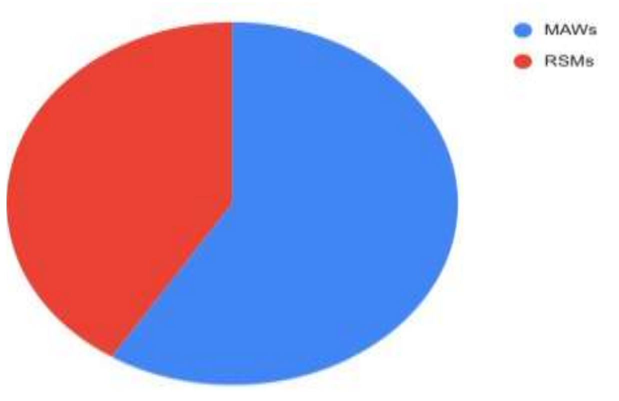

Figure 11. First-Time Fix Rate Values of the MAWs and RSM Workshops.

The results indicated that the average FIV for MAWs was 2.93 and 3.27 for RSM workshops, which indicated that the RSM workshops actually had more patronage than the MAWs at FIV for fixing. However, the average Fixed at First Initial Visit (FFIV), which indicated successful fixes at the initial visit for MAWs, was 70.3 % of success in the first attempt to fix a fault (FTFR). However, the FFIV for the RSMs indicated a FTFR of 29.7 %. These results revealed that MAWs have a higher chance of fixing an automobile at the FIV than the RSM workshops.

Figure 12 present results of rework rates (RRs) values of MAWs and RSM workshops under study.

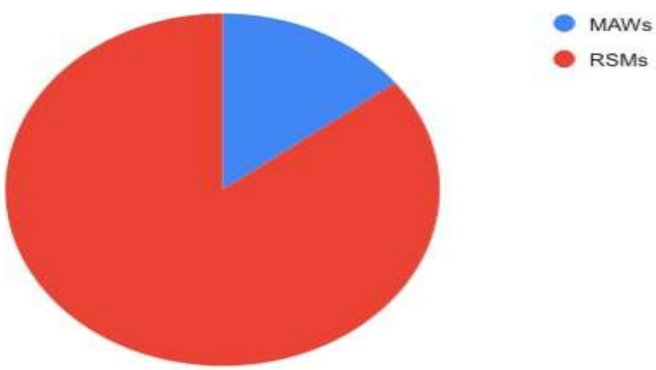

Figure 12. Comparison of the rework rate values of MAWs and RSM workshops.

It was earlier observed that RSMs had more patronage than MAWs, especially during the first initial visit for fixing. However, the average Brought-In-Rework (BIR), which indicates unsuccessful fixes at initial visits and are further brought in for re-fix, shows that the MAW value was 8.2 % RR. However, the value for RSM workshops was 91.8 %. The results revealed that MAWs had a lower incidence of BIR than RSM workshops. Rework rate values can be used to measure the accuracy and productivity efficiency of automobile workshops.

Figure 13 show the results obtained from the customers' responses to the questionnaires. Analysis of the questionnaires indicated that 68 % of customers who took their vehicles to the MAWs were satisfied with the repairs carried out in their vehicles. However, only 32 % of the customers of the RSM workshops were satisfied with the repairs done on their vehicles. The results show that the customers who took their vehicles for repairs to the MAWs were more satisfied with the repairs than those who patronized the RSMs workshops.

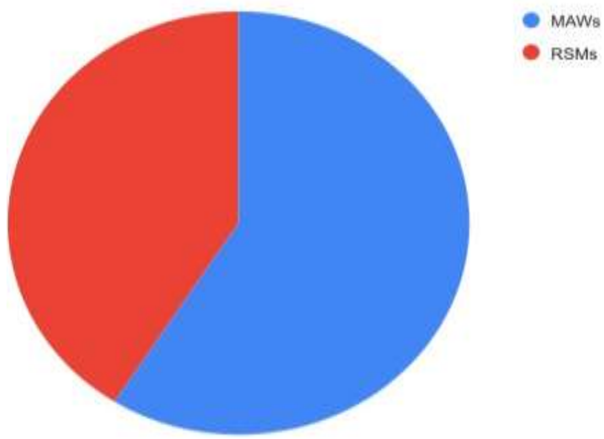

Figure 13. Comparison of the Customer Satisfaction Index for MWAs and RSM Workshops.

Figure 14 presents a comparison of the RCT between the MAWs and RSM workshops. The repair cycle time represents the time taken for repairs from the drop-off time (DOT) to the pick-up time (PUT). Only five RSM workshops shared the RCT data of their organizations; therefore, the data of MAWs closest to each of the five RSM workshops were used in the comparison. The average RCT for the MAWs was 192.6 min time lag, while that of the RSM workshops was 717 min. This indicates that the RSM workshops took longer to fix an automobile than the MAWs.

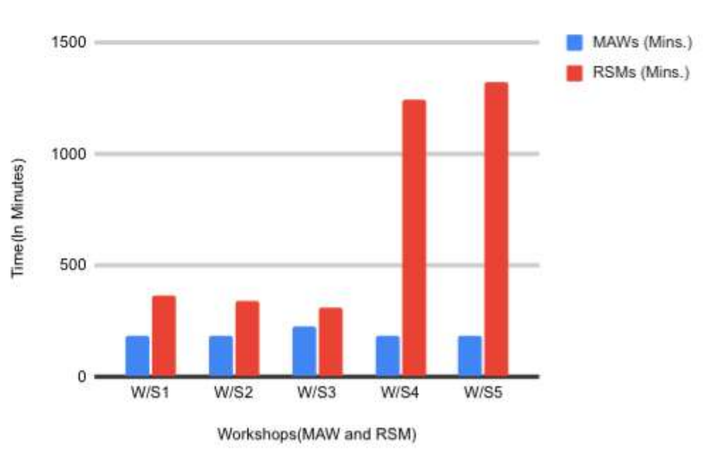

Figure 14. Comparison of repair cycle times between the MAWs and RSM workshops.

4. Conclusion

This study investigated the impact of modern workshop practices on the productivity of selected automotive workshops in Abuja, Nigeria. The findings revealed significant disparities in equipment availability and diagnostic capabilities between modern automobile workshops (MAWs) and traditional roadside mechanics (RSMs). The results revealed that MAWs have a higher chance of fixing an automobile at the FIV than at the RSM workshops. In addition, MAWs had a lower incidence of BIR than RSM workshops. Rework rate values can be used to measure the accuracy and productivity efficiency of automobile workshops. The results also indicated that customers who took their vehicles for repairs to the MAWs were more satisfied with the repairs than those who patronized the RSM workshops.

AUTHORS' BIBLIOGRAPHY

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Adamu Shanono received his initial higher education at Kaduna Polytechnic, where he obtained National and Higher National Diplomas in Mechanical Engineering. He then proceeded to Bayero University for the postgraduate diploma qualification in Mechanical Engineering, and the M. Eng. and PhD Energy Engineering degrees. Adamu served in the Nigerian Navy as a mechanical/marine engineer with over 20 years of experience in conducting condition-based, breakdown, and preventive maintenance at the operational level of the Navy and at the management level; planning, supervising, and monitoring maintenance activities on-board naval ships both ashore and afloat. Shanono is currently teaching at Baze University, Nigeria. From December 2022 to July 2025, he was the head of the Mechanical Engineering department while also supervising the Mechatronics Engineering course at Baze University. As the head of department, he supervised the successful compilation of 30 % content of Nigeria's National Universities Commission (NUC) Core Curriculum and Minimum Academic Standards document for both Mechanical and Mechatronics Engineering courses, and the NUC accreditation of Mechanical Engineering B.Eng. courses. Adamu Shanono is a registered mechanical engineer and fellow of the Institute of Management Consultants. He is a graduate of the Renewable Energy Academy of Germany and a member of the Standard Organisation of Nigeria (SON) national mirror/technical committee on construction and mining equipment. His areas of interest are artificial intelligence and renewable energy.

Chinonso Obasi

Chinonso Obasi began his education at Akanu Ibiam Federal Polytechnic Staff Primary School and then proceeded to Federal Government College, Okposi. He obtained a National Diploma and a Higher National Diploma in Mechanical Engineering from Akanu Ibiam Federal Polytechnic, followed by another Higher National Diploma in Welding Engineering Technology from the Petroleum Training Institute. He later obtained a Bachelor of Engineering degree in Mechanical Engineering from Gregory University, Uturu. He holds a Master's degree in Mechanical Engineering from Baze University, Abuja where he is currently pursuing a Ph. D. All institutions in Nigeria. Obasi is widely recognized for his leadership in the Nigerian student and youth movements. In 2016, he served as president of the National Association of Nigerian Students (NANS) and was the pioneer president of the Nigerian Youth Union (NYU). His passion lies in promoting accountability, integrity, good governance, and patriotism. He is a dedicated youth development consultant with a strong commitment to service and mentorship. His hobbies include driving, inspiring young people, and humanitarian engagement. Obasi is married and blessed with three children.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest in the research, survey, and writing of this manuscript.

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