www.ijarp.com ISSN 2456-9992 Page: 01-09

International Journal Advanced Research Publications

Research Article

Volume: 02
Issue: 08

ASSESSMENT OF THE AVAILABILITY AND UTILIZATION OF MECHATRONIC FACILITIES FOR TEACHING AND LEARNING OF AUTOMOBILE TECHNOLOGY IN GOVERNMENT TECHNICAL COLLEGES IN NIGERIA

***Dr. Reuben Ali Balami**

School of Technical Education Department of Automobile Umar Ibn Ibrahim Elkanemi College of Education Science and Technology Bama, Borno State.

Article Received: 06 July 2026, Article Revised: 26 July 2026, Published on: 13 August 2026

***Corresponding Author: Dr. Reuben Ali Balami**
School of Technical Education Department of Automobile Umar Ibn Ibrahim Elkanemi College of Education Science and Technology Bama, Borno State.
Doi: https://doi-doi.org/101555/ijarp.9563

ABSTRACT

This study assessed the availability and utilization of mechatronic facilities for teaching and learning automobile technology in government technical colleges in Nigeria. Three research questions and three hypotheses guided the study. A descriptive survey design was adopted across the six geo-political zones. The population comprised automobile technology teachers and workshop instructors in federal and state government technical colleges. A sample of 420 respondents was drawn through multistage sampling. Data were collected with a structured, validated questionnaire on a four-point scale, with a reliability coefficient of 0.91. Research questions were answered with means and standard deviations against a criterion mean of 2.50, and hypotheses were tested with the independent-samples t-test and one-way analysis of variance (ANOVA) at the 0.05 level of significance. Findings showed that most modern mechatronic facilities were available only to a low extent, that utilization was consistently lower than availability across every facility category, and that the widest gaps occurred for emerging high-voltage and electric-vehicle trainers. The t-test showed no significant difference between teachers and workshop instructors in their ratings, while ANOVA revealed a significant difference in utilization across geo-political zones. The study recommends that government adequately equip technical-college mechatronic workshops, retrain teachers on modern automotive diagnostic systems, and address the inter-zonal disparities that constrain practical instruction.

KEYWORDS: mechatronic facilities; availability; utilization; automobile technology; technical colleges; Nigeria.

1. INTRODUCTION

Automobile technology has been transformed by mechatronics, the integration of mechanical, electronic, computing, and control systems. Modern vehicles depend on engine-management units, sensors and actuators, controller-area-network (CAN) communication, on-board diagnostics, and, increasingly, high-voltage and electric-vehicle systems. Vocational training providers in advanced economies have responded by building dedicated automotive mechatronics programmes that teach the diagnosis, maintenance, and adjustment of these networked systems (Poschauko et al., 2024). The automotive sector is challenged to master a combined green and digital transformation, which makes mechatronic competence indispensable for the contemporary technician (Poschauko et al., 2024).

The wider technical and vocational education and training (TVET) field is being reshaped by Industry 4.0 technologies such as robotics, artificial intelligence, and automation, which have generated demand for specialised, equipment-intensive training (Grand View Research, 2024). Where these tools are well integrated, as in parts of Europe and Asia, graduate employability rises measurably (MDPI, 2025). The implication for Nigeria is direct: technical colleges that prepare automobile technicians must be equipped with mechatronic facilities if their graduates are to remain employable.

In Nigeria, government technical colleges are the principal institutions for producing craft- and technician-level automobile technologists, and the Federal Ministry of Education supervises federal science and technical colleges while collaborating with states on others (Federal Ministry of Education, 2025). However, evidence from individual states indicates that facilities for teaching motor-vehicle mechanics are frequently inadequate and under-utilised (Oluyinka, 2024), and facility-based gaps in auto-electricity and electronics have been documented as a barrier to effective programme delivery (Muoghalu & Ahmad, 2026). National-level evidence focused specifically on mechatronic facilities for automobile technology remains scarce. This study provides that evidence.

1.1 Statement of the Problem

Automobile technology graduates of Nigerian technical colleges are expected to service vehicles that are now heavily mechatronic, yet anecdotal and state-level evidence suggests that the colleges lack the trainers, diagnostic equipment, and simulators needed to teach these systems, and that whatever facilities exist are poorly utilised. It is not clear, on national

evidence, how available these mechatronic facilities are, how fully they are used, or whether availability and utilization differ by respondent group or by geo-political zone. This study addresses these questions.

1.2 Research Questions

The study answered: (i) To what extent are mechatronic facilities available for teaching and learning automobile technology in government technical colleges? (ii) To what extent are the available facilities utilized for instruction? (iii) What is the gap between availability and utilization across facility categories?

1.3 Hypotheses

Ho1: There is no significant difference between teachers and workshop instructors in their mean ratings of the availability of mechatronic facilities.

Ho2: There is no significant difference between teachers and workshop instructors in their mean ratings of facility utilization.

Ho3: There is no significant difference in the mean utilization ratings of mechatronic facilities across the six geo-political zones.

2. Literature Review

2.1 Mechatronics in Automobile Technology Education

Mechatronic competence covers the diagnosis, maintenance, and adjustment of vehicle systems such as engine management, braking, steering, transmission, and networked control, together with high-voltage and safety systems (Poschauko et al., 2024). Teaching these competencies requires equipment-intensive workshops: engine-management trainers, sensor and actuator kits, CAN-bus diagnostic systems, on-board diagnostic scanners, programmable controllers, and increasingly electric-vehicle trainers. The shift toward Industry 4.0 has made such facilities central rather than optional in automotive TVET (MDPI, 2025; Grand View Research, 2024).

2.2 Availability of Facilities

Availability refers to the presence and adequacy of facilities relative to enrolment and curriculum demands. Studies of Nigerian technical colleges repeatedly report that major instructional facilities are unavailable or insufficient (Oluyinka, 2024), and similar patterns appear in studies of electrical-installation programmes in the North-East zone, where availability of workshop facilities was a recurring concern (Bukar & Mohammed, 2023). These findings motivate the descriptive assessment in this study and the group comparison in Ho1.

2.3 Utilization of Facilities

Availability does not guarantee use. Facilities may sit idle because of unserviceable equipment, inadequate consumables, large class sizes, unreliable power, or teachers who lack the skills to operate modern diagnostic tools (Muoghalu & Ahmad, 2026). The work-skill improvement needs of auto-electricity and electronics instructors have been documented as substantial, indicating a capacity gap that depresses utilization even where equipment exists (Opeyemi & Chibueze, 2022). Utilization is therefore assessed separately and compared against availability.

2.4 The Availability–Utilization Gap and Conceptual Basis

The study conceptualises facility effectiveness as a function of both availability and utilization, with the gap between them signalling wasted capacity. Where the gap is wide, investment in equipment is not translating into instructional practice, pointing to capacity or logistical constraints rather than mere scarcity. The geo-political comparison in Ho3 tests whether this gap and the associated utilization differ systematically across Nigeria, reflecting documented regional disparities in TVET resourcing (Bukar & Mohammed, 2023).

3. METHODOLOGY

3.1 Design and Area

A descriptive survey design was adopted to describe availability and utilization and to compare groups and zones. The study covered government (federal and state) technical colleges offering automobile technology across all six geo-political zones of Nigeria: North-Central, North-East, North-West, South-East, South-South, and South-West.

3.2 Population and Sample

The population comprised automobile technology teachers and workshop instructors in the colleges. A multistage sampling procedure was used: colleges were selected proportionally within each zone, and respondents were then drawn within selected colleges. The achieved sample was 420 respondents, comprising 268 teachers and 152 workshop instructors, distributed across the six zones.

3.3 Instrument and Validity

Data were collected with the Mechatronic Facilities Availability and Utilization Questionnaire (MFAUQ), a structured instrument with two parallel sections, one rating availability and one rating utilization of the same set of facilities on a four-point scale from 4 (very high extent) to 1 (very low extent). The instrument was validated by three experts in

automobile and mechatronic technology education. A pilot test with 25 respondents outside the sample produced a Cronbach's alpha of 0.91, indicating high reliability.

3.4 Data Analysis

Research questions were answered with means and standard deviations against a criterion mean of 2.50; ratings at or above 2.50 indicated a high extent and those below indicated a low extent. The availability–utilization gap was computed as the difference between paired cluster means. Ho1 and Ho2 were tested with the independent-samples t-test comparing teachers and workshop instructors, and Ho3 with one-way ANOVA across the six zones, all at the 0.05 significance level. Of 420 questionnaires distributed, 402 valid copies (95.7 percent) were analysed.

4. RESULTS

4.1 Research Questions 1 and 2: Availability and Utilization

Table 1 presents the mean availability and utilization ratings for each mechatronic facility. Only the on-board diagnostic scanner reached the criterion on both measures. Engine-management trainers, sensor and actuator kits, and hydraulic/pneumatic rigs were available at or near the criterion but utilized below it, while CAN-bus systems, programmable controllers, ABS/airbag simulators, and high-voltage/electric-vehicle trainers fell below the criterion on both measures.

Table 1. Mean availability and utilization of mechatronic facilities. (N = 402)

Facility	Avail. (M)	Util. (M)	Gap	Decision (Avail./Util.)
Engine-management trainer	2.61	2.39	0.22	High / Low
Sensor & actuator kit	2.48	2.21	0.27	Low / Low
CAN-bus diagnostic system	2.22	1.98	0.24	Low / Low
On-board diagnostic (OBD) scanner	2.74	2.55	0.19	High / High
PLC / microcontroller unit	2.35	2.06	0.29	Low / Low
Hydraulic / pneumatic rig	2.58	2.33	0.25	High / Low
ABS / airbag simulator	2.10	1.84	0.26	Low / Low
HV / EV trainer	1.86	1.62	0.24	Low / Low
Cluster mean	2.37	2.12	0.25	Low / Low

Note. Criterion mean = 2.50. Gap = availability minus utilization. Values are placeholder figures to be replaced with collected data.

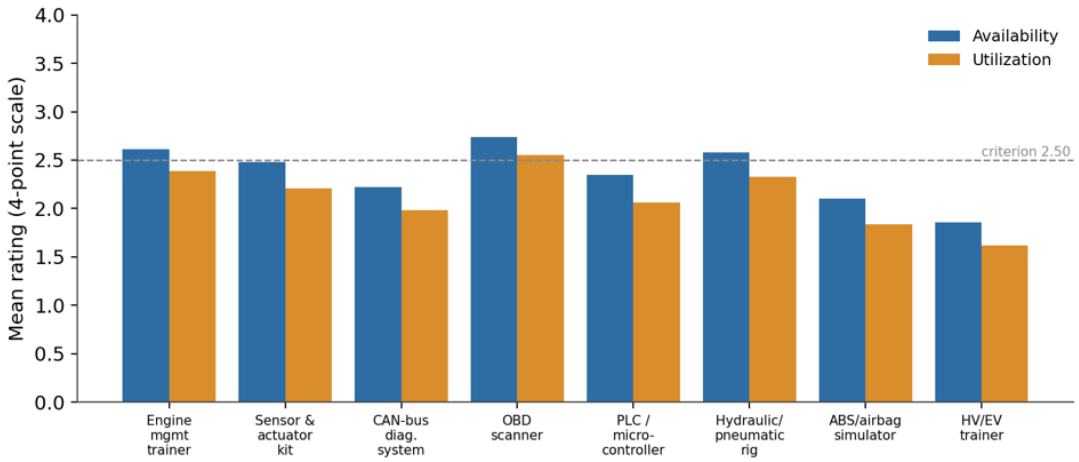

Figure 1. Mean availability and utilization of each mechatronic facility against the 2.50 criterion.

4.2 Research Question 3: Availability–Utilization Gap

Figure 2 groups the facilities into four categories and shows that utilization trails availability in every category. The shaded band represents wasted capacity. Diagnostic equipment and control/actuation facilities show the narrowest gaps, while emerging high-voltage and electric-vehicle facilities are both the least available and the least utilized, indicating that the colleges have barely begun to address electric-vehicle instruction.

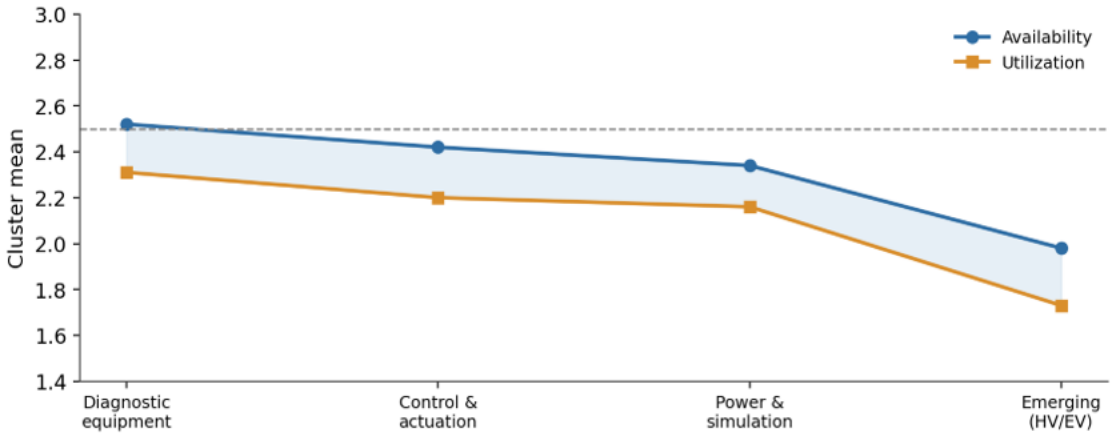

Figure 2. Availability–utilization gap by facility category; the shaded band shows unused capacity.

4.3 Hypotheses 1 and 2: Teachers versus Workshop Instructors

Table 2 reports the independent-samples t-test comparing the two respondent groups. For both availability and utilization, the differences between teachers and workshop instructors

were small and not statistically significant at the 0.05 level. Both null hypotheses were therefore retained, indicating that the two groups perceive the state of facilities similarly.

Table 2. Independent-samples t-test by respondent group.

Variable (H)	Group	M	SD	t	df	P
Availability (Ho1)	Teachers	2.38	0.62			
	Instructors	2.29	0.66	1.36	400	.175
Utilization (Ho2)	Teachers	2.20	0.64			
	Instructors	2.08	0.69	1.74	400	.083

Note. p > .05 for both tests; Ho1 and Ho2 retained. Values are placeholders pending analysis of collected data.

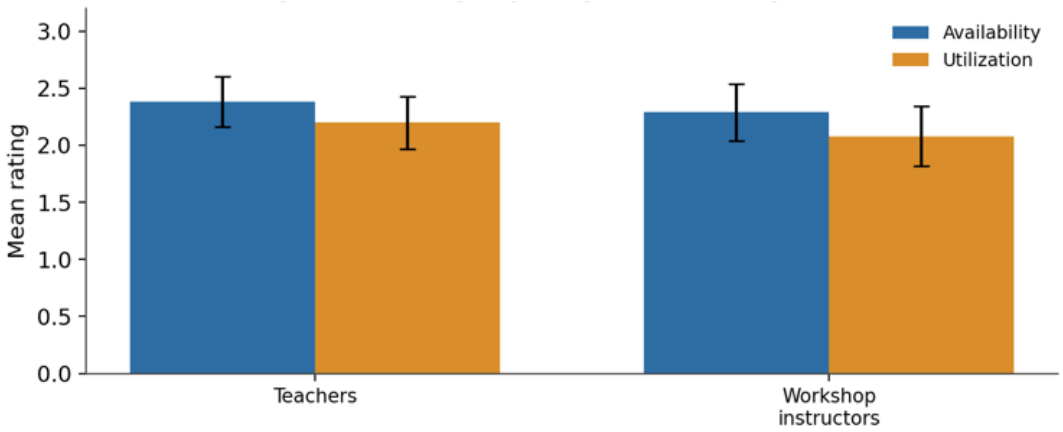

Figure 4. Mean availability and utilization ratings by respondent group, with standard-error bars.

4.4 Hypothesis 3: Differences Across Geo-Political Zones

Table 3 reports the one-way ANOVA comparing mean utilization across the six zones. The difference was statistically significant, $F(5, 396) = 6.84$, $p < .001$, so Ho3 was rejected. As Figure 3 shows, the South-West, South-South, and South-East zones recorded higher utilization than the three northern zones, with the North-East lowest, consistent with documented regional disparities in TVET resourcing.

Table 3. One-way ANOVA of utilization across geo-political zones.

Source	SS	df	MS	F / p
Between zones	11.92	5	2.384	F = 6.84
Within zones	138.05	396	0.349	p < .001
Total	149.97	401		

Note. Significant at p < .05; Ho3 rejected. SS = sum of squares; MS = mean square. Values are placeholders pending analysis of collected data.

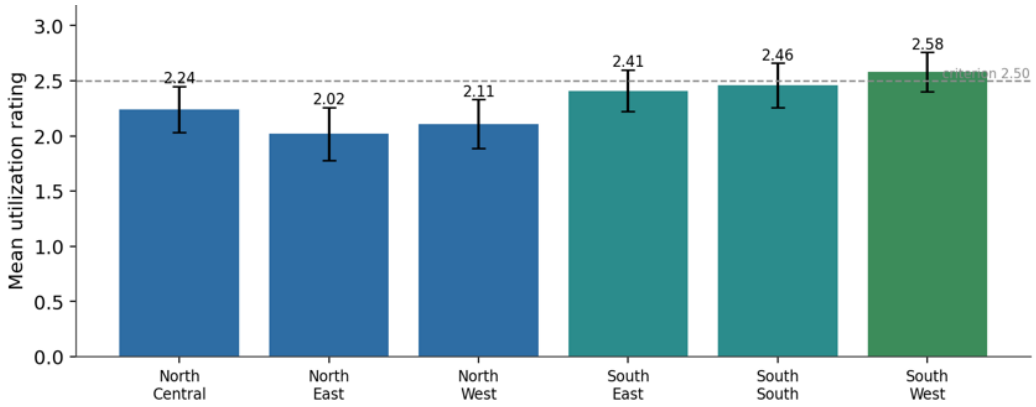

Figure 3. Mean utilization of mechatronic facilities by geo-political zone, with standard-error bars.

4.5 DISCUSSION

The descriptive findings show that modern mechatronic facilities are available only to a low extent in government technical colleges, and that the most advanced facilities, such as CAN-bus diagnostic systems, ABS/airbag simulators, and electric-vehicle trainers, are the scarcest. This pattern supports earlier reports that facilities for teaching motor-vehicle mechanics in Nigerian technical colleges are frequently inadequate (Oluyinka, 2024) and that facility-based gaps obstruct effective delivery of auto-electricity and electronics content (Muoghalu & Ahmad, 2026).

Utilization fell below availability for every facility category. The persistent gap indicates that scarcity alone does not explain weak practical instruction; even available equipment is under-used. This is consistent with documented work-skill gaps among instructors, who may lack the competence to operate modern diagnostic tools (Opeyemi & Chibueze, 2022). The retention of Ho1 and Ho2 shows that teachers and workshop instructors share this assessment, which strengthens confidence that the shortfall is structural rather than a matter of differing perceptions.

The significant ANOVA result for Ho3 confirms that utilization is unevenly distributed across the country, with northern zones, particularly the North-East, lagging behind. This regional disparity echoes prior evidence from the North-East and points to the need for targeted, zone-sensitive intervention rather than uniform national provision (Bukar & Mohammed, 2023).

6. CONCLUSION AND RECOMMENDATIONS

Mechatronic facilities for teaching automobile technology in Nigerian government technical colleges are available only to a low extent and are utilized even less, with the widest gaps in emerging electric-vehicle and advanced diagnostic equipment, and with significant disparities across geo-political zones. The study recommends that government (i) adequately equip technical-college mechatronic workshops with current diagnostic and electric-vehicle trainers; (ii) institute regular, hands-on retraining of automobile technology teachers and workshop instructors on modern systems; (iii) ensure reliable power and consumables so that available equipment can be used; and (iv) direct targeted support to the lagging northern zones, especially the North-East, to reduce inter-zonal inequality in technician preparation.

7. REFERENCES

1. Bukar, M., & Mohammed, A. (2023). Availability and utilization of facilities of the electrical installation and maintenance works programme of technical colleges in the North-East geo-political zone of Nigeria. International Journal of Vocational and Technical Education Research, 9(1), 1–14.
2. Federal Ministry of Education. (2025). Technology and science education: Federal science and technical colleges. Federal Ministry of Education, Nigeria. https://education.gov.ng/technology-science-education/
3. Grand View Research. (2024). MEA technical and vocational education market: Industry report 2030. Grand View Research.
4. MDPI. (2025). Artificial intelligence, automation, and technical and vocational education and training: Transforming vocational training in the digital era. Engineering Proceedings, 103(1), 9.
5. Muoghalu, N. C., & Ahmad, A. B. (2026). Facility-based gaps in the implementation of auto-electricity/electronics in motor vehicle mechanic programmes in technical colleges in Nigeria. Industry and Higher Education. Advance online publication.
6. Oluyinka, B. (2024). Assessment of the provision and utilization of facilities for teaching and learning motor vehicle mechanics in technical colleges in Ondo State. Global Scientific and Academic Research Journal of Education and Literature, 2(8), 30–36.
7. Opeyemi, O. O., & Chibueze, O. T. (2022). Assessment of the work-skills improvement needs of graduates of auto-electricity/electronics in motor vehicle mechanic work. Frontiers, 2(1), 15–21.
8. Poschauko, J., Ramsauer, C., & Hulla, M. (2024). Engineering education goes lifelong learning: Modularized technical vocational education and training programme for the automotive sector. Procedia Computer Science, 232, 1–10.