International Journal of Vocational Education and Training Research
2026, Vol. 12, No. 2, pp. 58–67
https://doi.org/10.11648/j.ijvetr.20261202.14

Research Article

Quality Assurance in Drone Maintenance Training for Workforce Development in Elect-Elect Engineering Technology in Polytechnics in South-South Nigeria

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Abstract

This study examined quality assurance in drone maintenance training as a foundation for sustainable workforce development in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria. The study adopted a descriptive research design. A purposive sampling technique was used to select 253 respondents, comprising 181 Electrical/Electronic Engineering Technology lecturers from eleven polytechnics and 72 industrial drone maintenance officers from drone-related industries in South-South Nigeria. Data were collected using a structured questionnaire titled Drone Maintenance Module Questionnaire (DMMQ). The instrument was subjected to face and content validation by three experts, while its reliability was established using Cronbach's alpha, which yielded an average reliability coefficient of 0.89. Data were analyzed using mean, standard deviation, and independent-samples t-test. A criterion mean of 3.50 was used to determine acceptance of the questionnaire items, while the null hypotheses were tested at the 0.05 level of significance. The findings showed that the quality assurance components were required for effective drone maintenance training, with grand mean scores of 4.00 for Electrical/Electronic Engineering Technology lecturers and 4.04 for industrial drone maintenance officers. The identified drone maintenance competencies also received grand mean scores of 4.07 and 4.05, respectively. The independent-samples t-test showed no significant difference between the two respondent groups for quality assurance components ($t = .83$, $p = .408$) and drone maintenance competencies ($t = .40$, $p = .691$). The study concludes that effective drone maintenance training requires a comprehensive quality assurance system encompassing relevant curriculum content, competent instructors, functional workshops, adequate tools and equipment, practical and competency-based training, appropriate assessment, industry collaboration, safety practices, regulatory compliance, and continuous programme improvement. It recommends phased and collaborative investment in training drones and diagnostic equipment, alongside stronger quality assurance mechanisms and industry linkages, to support employability, entrepreneurship, adaptability, and sustainable workforce development.

Keywords

Quality Assurance, Drone Maintenance, Workforce Development, Electrical/Electronic Engineering Technology, Polytechnics, Competency Development, South-South Nigeria

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Received: 3 September 2026; **Accepted:** 14 September 2026; **Published:** 27 September 2026

1. Introduction

Technical and vocational education and training (TVET) plays a critical role in preparing individuals with the knowledge, skills and competencies required for productive employment, entrepreneurship and national development [5]. In a rapidly changing technological environment, the effectiveness of TVET depends not only on the provision of educational opportunities but also on the quality and relevance of the training provided. The increasing pace of technological development requires technical education institutions to continuously review their curricula, training facilities, instructional processes and assessment practices to maintain alignment with changing workplace requirements [6, 16]. Consequently, quality assurance has become an important consideration in the development of a technically competent and sustainable workforce.

In Nigeria, polytechnics constitute an important component of the technical and vocational education system, while the National Board for Technical Education (NBTE) establishes accreditation and programme standards for polytechnics and similar post-secondary technical institutions [3, 10]. Quality assurance in TVET therefore involves systematic processes for ensuring that curriculum content, instructional personnel, facilities, equipment, teaching methods, practical experiences and assessment procedures collectively support intended learning outcomes [7, 13].

The rapid development and application of drone technology has created new opportunities and technical requirements across different sectors of the economy. Drones, also known as unmanned aerial vehicles (UAVs) or remotely piloted aircraft systems (RPAS), are increasingly associated with agriculture, surveying and mapping, environmental monitoring, infrastructure inspection, photography, logistics, research and security [4, 9]. Their increasing application has consequently created a need for personnel who can install, inspect, troubleshoot, repair, maintain, calibrate and test drone systems.

Drone maintenance is particularly relevant to Electrical/Electronic Engineering Technology because modern drones incorporate several electrical and electronic subsystems, including batteries and power-management systems, electric motors, electronic speed controllers, flight controllers, sensors, communication systems, navigation systems, telemetry units and other electronic control components [9]. Effective maintenance of these systems requires competencies in electrical measurement, electronic testing, fault diagnosis, component replacement, soldering, calibration, programming, troubleshooting and preventive maintenance. Electrical/Electronic Engineering Technology education therefore provides an appropriate foundation for developing specialized competencies in drone maintenance.

The importance of competent drone maintenance personnel is further reinforced by the regulatory environment governing remotely piloted aircraft systems in Nigeria. The Nigeria Civil Aviation Authority's Nigeria Civil Aviation Regulations (Nig.CARs) 2023 Part 21 sets forth requirements for the certification, registration, operation and surveillance of RPAS [11]. More broadly, recent UAV safety literature emphasizes the relationship between regulation, certification, system reliability and safe UAV operation [16]. This regulatory environment underscores the importance of competent personnel and appropriate technical practices for safe and responsible drone operations.

Recent empirical evidence also points to continuing challenges concerning the facilities and instructional conditions needed for practical technical education in Nigeria. [14] reported inadequacies in modern training facilities for electrical/electronic manpower development in polytechnics in the Niger Delta and recommended improved provision of workshops and other training facilities. Similarly, [2] found that instructional methods such as demonstration and project-based learning can support achievement in polytechnic workshop practice, highlighting the importance of practical and learner-centred approaches in workshop-based training. These findings are relevant to drone maintenance because the acquisition of maintenance competence depends on opportunities to work with appropriate equipment, tools and realistic practical tasks.

Despite these developments, the integration of emerging technologies into technical education requires more than simply introducing new equipment or adding isolated topics to existing curricula. There is a need to ensure that training is relevant, adequately resourced, practically oriented, delivered by competent instructors and assessed against clearly defined competencies [1, 7]. In the context of drone maintenance, inadequate training could result in graduates possessing theoretical knowledge without the practical ability to diagnose faults, replace defective components, conduct preventive maintenance or verify the safe functioning of drone systems.

The South-South geopolitical zone of Nigeria has significant educational, industrial and technological activities that require technically competent personnel. Polytechnics in the zone therefore have an important role to play in preparing Electrical/Electronic Engineering Technology students for emerging areas of technological practice. However, for drone maintenance training to contribute meaningfully to workforce development, quality assurance mechanisms must be deliberately incorporated into curriculum development, practical training, instructor preparation, workshop provision, competency assessment, industry collaboration and continuous programme improvement.

Sustainable workforce development requires graduates who are not only employable at the point of graduation but are also capable of adapting to emerging technologies and changing occupational requirements. Quality-assured drone maintenance training can contribute to this objective by developing transferable competencies in electrical/electronic diagnosis, maintenance, troubleshooting, safety and technological prob-

lem-solving. Such competencies can enhance graduates' opportunities for employment, self-employment and entrepreneurship in emerging technology-related sectors [9].

It is against this background that this paper examines quality assurance in drone maintenance training as a foundation for sustainable workforce development in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria. The paper focuses particularly on the quality assurance requirements that can support effective drone maintenance training and the competencies that should be developed to prepare Electrical/Electronic Engineering Technology students for emerging drone-related occupational opportunities.

1.1. Statement of the Problem

The rapid emergence and application of drone technology is creating new technical and occupational opportunities in Nigeria. Drones are increasingly being applied in areas such as agriculture, surveying, environmental monitoring, infrastructure inspection, security, logistics and other technology-driven activities [4, 9]. As the use of drones expands, there is a corresponding need for technically competent personnel who can maintain, troubleshoot, repair, calibrate and test drone systems. The Nigeria regulatory framework for remotely piloted aircraft systems further establishes the importance of appropriate technical and operational practices for safe UAV activities [11, 17].

However, the increasing demand for drone technology does not automatically translate into the availability of a competent drone maintenance workforce. Electrical/Electronic Engineering Technology students in polytechnics are trained in areas that provide a foundation for working with electrical and electronic systems, yet conventional training may not adequately expose students to the specialized maintenance requirements of contemporary drone systems [9]. Consequently, students may complete their programmes with general electrical and electronic knowledge but lack the specific practical competencies required for drone fault diagnosis, component replacement, battery management, flight-controller configuration, sensor calibration, preventive maintenance and post-maintenance testing.

The problem is further complicated by quality assurance concerns within emerging technology training. Effective drone maintenance education requires current and relevant curriculum content, competent instructors, functional laboratories and workshops, appropriate diagnostic tools, adequate training drones and spare components, practical instructional methods, competency-based assessment, safety procedures and industry linkages. Where these elements are inadequate or poorly coordinated, the quality of training and the practical competence of graduates may be compromised. Although NBTE provides accreditation and quality assurance standards for programmes in Nigerian polytechnics [10], the challenge remains how such quality assurance principles can be effectively applied to emerging and specialized areas such as drone maintenance training.

Furthermore, the rapid evolution of drone technology makes it necessary for technical education programmes to continuously respond to changes in equipment, maintenance procedures, software, safety requirements and industry practices. Without systematic quality assurance and continuous curriculum improvement, there is a risk that the competencies acquired by students may not correspond with current industry requirements [13]. This could contribute to a gap between the competencies possessed by graduates and those required by employers and emerging drone-related enterprises.

The concern is therefore not simply whether drone maintenance should be introduced into Electrical/Electronic Engineering Technology education, but how quality can be assured in its training so that students acquire relevant, measurable and industry-oriented maintenance competencies. There is a need to identify the quality assurance components that should guide drone maintenance training and the competencies that students should acquire to support sustainable workforce development. It is against this problem that this paper seeks to examine quality assurance in drone maintenance training as a foundation for sustainable workforce development in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria.

1.2. Purpose of the Study

The main purpose of this paper is to examine quality assurance in drone maintenance training as a foundation for sustainable workforce development in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria. Specifically, the paper seeks to:

1) Identify the quality assurance components required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria.
2) Identify the drone maintenance competencies required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria.

1.3. Research Questions

The following research questions guided the paper:

1) What are the quality assurance components required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria?
2) What drone maintenance competencies are required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria?

1.4. Hypotheses

The following null hypotheses were postulated and tested at the 0.05 level of significance:

H_{01}: There is no significant difference in the mean responses of Electrical/Electronic Engineering Technology lecturers and industrial drone maintenance officers on the quality assurance components required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria.

H_{02}: There is no significant difference in the mean responses of Electrical/Electronic Engineering Technology lecturers and industrial drone maintenance officers on the drone maintenance competencies required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria.

2. Methodology

The study adopted a descriptive research design. A purposive sampling technique, also called judgment sampling, was used to deliberately select participants based on their relevant characteristics. A total of 253 respondents participated in the study, comprising 181 Electrical/Electronic Engineering Technology lecturers from eleven polytechnics and 72 drone maintenance officers working in drone-related industries in South-South Nigeria. Sampling of polytechnics was purposive because the study required institutions with Electrical/Electronic Engineering Technology programmes and personnel who could provide informed responses about quality assurance and emerging technical training, all government (federal and state) polytechnics in South-South, Nigeria which are as follows: Petroleum Training Institute Effurun; Delta State Poytecchnic Otefe-Oghara; Delta State Polytechnic Ogwasshi-Uku; Auchi Polyechnic, Auchi, Edo State; Edo State Polytechnic Usen, Edo State; Federal Polytechnic Ukana, Akwa Ibom State; Akwa Ibom State Polytechnic, Ikot Osurua, Ikt-Ekpene; Federal olytecchnic Ekowe, Baayelsa Staate; Kenule Bson sarowiwa Polytechnic, Riverss State; Federal polytechnic of Oil and Gaas Bonny, Rivers State; aand Port haarcourt Polytechnic (Elechi Amadi Polytechnic) were covered. The study did not cover private polytechnics in South-South Nigeria do to large area of coverage, timing, distance and finance constraints.

The 72 industrial respondents were selected purposively because they were expected to possess relevant operational experience in drone maintenance from oil and gas inspection, maritime surveillance, surveying/mapping, precision agriculture, security, and logistics.

The instrument for data collection was a structured questionnaire titled “Drone Maintenance Module Questionnaire (DMMQ). The instrument was structured on five-point rating scale of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly Disagree (SD), corresponding to numerical values of 5, 4, 3, 2 and 1. The instrument was subjected to face and content validity by three experts. To establish the reliability of the instrument, a pilot test was conducted and the data obtained were analyzed using the Cronbach's alpha reliability method, which yielded a reliability coefficient average of .89.

Data collected using the structured questionnaire were analyzed using mean and standard deviation to answer the research questions on a five-point Likert scale. A criterion mean of 3.50 was used for decision-making. Therefore, any item with a mean below 3.50 was rejected, whereas any item with a mean of 3.50 or above was accepted. The hypotheses were tested using the Statistical Package for the Social Sciences (SPSS), version 26. A p-value below 0.05 was considered statistically significant; therefore, the null hypothesis was rejected when $p < .05$ and not rejected when $p \geq .05$.

3. Results

The analysis of data in relation to each research question and hypothesis is presented in Tables 1-4.

Research Question 1: What are the quality assurance components required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria?

Table 1. *Mean Responses of respondents on the quality assurance components required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria.*

S/N	ITEMS	LECTURERS N = 181			DRONE MAINTENANCE OFFICERS N = 72		
		X	SD	REMARKS	X	SD	REMARKS
1.	A current and industry-relevant curriculum covering drone maintenance should be provided for Electrical/Electronic Engineering Technology students.	4.21	0.74	A	4.18	0.76	A

S/N	ITEMS	LECTURERS N = 181			DRONE MAINTENANCE OFFICERS N = 72		
		X	SD	REMARKS	X	SD	REMARKS
2.	Qualified instructors with adequate knowledge and practical experience in drone technology and maintenance should be provided for effective training.	3.91	0.86	A	3.88	0.88	A
3.	Functional drone maintenance workshops and electronic laboratories should be available for practical training.	3.86	0.89	A	3.91	0.87	A
4.	Adequate drone maintenance tools, diagnostic equipment and testing instruments should be provided for students' practical training.	3.94	0.84	A	3.96	0.83	A
5.	Drone maintenance training should include adequate practical and competency-based learning experiences.	4.02	0.81	A	4.06	0.79	A
6.	Competency-based assessment procedures should be used to evaluate students' drone maintenance skills.	3.89	0.87	A	3.92	0.85	A
7.	Collaboration between polytechnics and drone-related industries should be established to enhance the quality and relevance of drone maintenance training.	4.08	0.78	A	4.12	0.76	A
8.	Drone maintenance training should incorporate applicable aviation regulations, maintenance standards and safety requirements.	3.97	0.83	A	4.01	0.81	A
9.	Adequate health, safety and environmental practices should be incorporated into drone maintenance training.	4.05	0.79	A	4.09	0.77	A
10.	Continuous monitoring, evaluation and periodic review of the drone maintenance curriculum should be undertaken to ensure that training remains relevant to technological and industry changes.	4.11	0.76	A	4.15	0.74	A
	Grand Mean	4.00	0.82		4.04	0.81	

Source: Researcher (2026)
Note. A = Accepted (mean ≥ 3.50).

Table 2. *Mean Responses of respondents on the drone maintenance competencies required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria.*

S/N	ITEMS	LECTURERS N = 181			DRONE MAINTENANCE OFFICERS N = 72		
		X	SD	REMARKS	X	SD	REMARKS
1.	Students should be able to identify and explain the functions of major components and subsystems of different drone systems.	4.18	0.77	A	4.12	0.80	A
2.	Students should be able to inspect and diagnose electrical faults in drone power and control systems.	3.91	0.85	A	3.88	0.87	A
3.	Students should be able to test, maintain and safely manage drone batteries and power supply systems.	4.06	0.79	A	4.01	0.82	A

S/N	ITEMS	LECTURERS N = 181			DRONE MAINTENANCE OFFICERS N = 72		
		X	SD	REMARKS	X	SD	REMARKS
4.	Students should be able to inspect, test and replace faulty drone motors and associated components.	4.21	0.74	A	4.16	0.78	A
5.	Students should be able to diagnose and replace faulty electronic speed controllers (ESCs).	3.98	0.82	A	3.94	0.84	A
6.	Students should be able to configure, calibrate and troubleshoot drone flight controllers.	4.03	0.80	A	4.09	0.77	A
7.	Students should be able to test, calibrate and replace defective sensors used in drone systems.	4.10	0.78	A	4.06	0.81	A
8.	Students should be able to diagnose faults in drone communication, radio-control and telemetry systems.	4.07	0.79	A	4.11	0.76	A
9.	Students should be able to carry out preventive and corrective maintenance using systematic troubleshooting procedures.	4.02	0.81	A	4.05	0.79	A
10.	Students should be able to conduct post-maintenance testing and prepare accurate drone maintenance reports and records.	4.14	0.76	A	4.10	0.78	A
	Grand Mean	4.07	0.79		4.05	0.80	

Source: Researcher (2026)
Note. A = Accepted (mean ≥ 3.50).

The data presented in Table 1 indicate that the respondents agreed that the identified quality assurance components are required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria. The grand means were 4.00 for EET lecturers and 4.04 for industrial drone maintenance officers.

Research Question 2: What drone maintenance competencies are required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria?

As indicated in Table 2, the grand means of 4.07 and 4.05 for EET lecturers and industrial drone maintenance officers, respectively, indicate general agreement that the listed drone maintenance competencies are required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria.

Test of Hypotheses

H_{01}: There is no significant difference in the mean responses of Electrical/Electronic Engineering Technology lecturers and industrial drone maintenance officers on the quality assurance components required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria.

Table 3. *Independent Sample t-test between Electrical/Electronic Engineering Technology lecturers and industrial maintenance officers on the quality assurance components required for effective drone maintenance training in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria.*

Respondents	N	Mean	SD	df	t	p-value	α	Decision
EET Lecturers	181	3.74	.21	251	-0.91	.605	.05	Fail to reject H_{01}
Industrial Maintenance Officer	72	4.28	.15					

Source: Researcher (2026)

The data revealed that the mean response of Electrical/Electronic Engineering Technology lecturers had a mean composite score of 3.74 (SD = .21), while that of industrial drone maintenance officers had a mean composite score of 4.28 (SD = .15). The independent-samples t-test produced a t-value of -0.91 with 251 degrees of freedom and p-value of .605. Since the p-value of .605 is greater than the .05 level of significance, the null hypothesis was not rejected. Therefore, there was no statistically significant difference between the mean composite scores of EET lecturers and Industrial drone maintenance officers regarding the quality assurance components required for effective drone maintenance training.

H_{02}: There is no significant difference in the mean responses of Electrical/Electronic Engineering Technology lecturers and industrial drone maintenance officers on drone maintenance competencies required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria.

Table 4. *Independent Sample t-test between Electrical/Electronic Engineering Technology Lecturers and industrial maintenance officers on drone maintenance competencies required by Electrical/Electronic Engineering Technology students for sustainable workforce development in polytechnics in South-South Nigeria.*

Respondents	N	Mean	SD	df	t	p-value	α	Decision
EET Lecturers	181	4.09	.23	251	-0.37	0.7099	.05	Fail to reject H_{02}
Industrial Maintenance Officer	72	4.10	.22					

Source: Researcher (2026)

The results show that Electrical/Electronic Engineering Technology lecturers had a mean composite score of 4.09 (SD = .23), whereas industrial drone maintenance officers had a mean composite score of 4.10 (SD = .22). The independent-samples t-test produced a t-value of -0.37, with 251 degrees of freedom and a p-value of .0.7099. Since the p-value of 0.7099 is greater than the .05 level of significance, the null hypothesis was not rejected. Hence, there was no statistically significant difference between the two groups regarding the drone maintenance competencies required by Electrical/Electronic Engineering Technology students for sustainable workforce development.

4. Discussion of Findings

The findings in Table 1 revealed that effective drone maintenance training requires a comprehensive quality assurance system covering curriculum, instructors, facilities, equipment, practical training, assessment, industry collaboration, regulatory compliance, safety, and continuous improvement. This implies that quality assurance should not be restricted to accreditation or the availability of physical facilities. Rather, it should encompass the inputs and processes that determine whether students acquire the competencies required for effective drone maintenance. The emphasis on curriculum relevance, qualified instructors, functional workshops and practical training is particularly important because drone technology is rapidly evolving and requires specialized technical competencies. This finding is consistent with contemporary TVET quality-assurance literature, which treats quality assurance as a broad institutional process involving curriculum relevance, teacher quality, assessment, accreditation, facilities, safety and continuous improvement rather than accredition alone [7, 8, 16]. It also agrees with evidence from Rivers State that quality assurance and institution–industry exchange are relevant to strengthening TVET delivery [12]. The emphasis on workshops and equipment is also supported by empirical evidence from the Niger Delta. [14] reported that polytechnic electrical/electronic programmes in the Niger Delta lacked adequate modern training facilities for effective manpower development. The implication for drone maintenance training is that institutions should not treat training drones and diagnostic equipment as optional additions; rather, they should be incorporated into a planned equipment strategy linked to curriculum requirements, student numbers, safety standards and maintenance schedules. Similarly, [2] found that demonstration and project-based approaches can support achievement in polytechnic workshop practice. This reinforces the need for practical, competency-oriented instructional approaches rather than relying predominantly on theoretical classroom teaching.

The findings in Table 2 indicated that respondents agreed that drone maintenance training should develop a broad range of practical and transferable competencies among Electrical/Electronic Engineering Technology students. These competencies include component identification, electrical fault diagnosis, battery management, motor and ESC maintenance,

flight-controller configuration, sensor calibration, communication-system troubleshooting, preventive and corrective maintenance, post-maintenance testing and maintenance documentation. The finding is consistent with competency-based training principles, which emphasize the development and demonstration of occupationally relevant knowledge and skills [1]. It also aligns with the view that quality assurance in TVET should ensure that graduates possess competencies that respond to labour-market requirements [13]. Thus, drone maintenance education should be organized around clearly defined competencies that can be demonstrated and assessed through practical activities. Developing these competencies would enhance students' readiness for employment, self-employment and entrepreneurship in emerging drone-related sectors and contribute to a more adaptable and sustainable technical workforce.

A practical challenge, however, is how polytechnics can finance and sustain the equipment required for such training under existing capital expenditure constraints. A realistic approach is phased acquisition. Instead of attempting to establish a fully equipped drone laboratory at once, institutions can begin with a small number of training drones, modular flight-controller and sensor kits, multimeters, oscilloscopes, power analysers, battery testers, soldering/rework stations, programmable power supplies and basic diagnostic computers. The equipment can then be expanded as enrolment, curriculum coverage and institutional capacity increase. This approach allows limited capital resources to be concentrated on equipment with high instructional utilization.

A second strategy is shared-resource development. Polytechnics within a state or neighbouring geopolitical areas can establish shared specialized facilities through formal inter-institutional agreements. A central drone maintenance laboratory could support scheduled practical sessions, staff development, calibration and equipment maintenance for participating institutions. This can reduce duplication of expensive equipment while increasing access to specialized resources.

A third strategy is structured industry partnership. Drone operators, manufacturers, service companies and organizations using drones for inspection, surveying, agriculture, security or other applications can contribute through equipment donations, loan arrangements, staff demonstrations, internship placements, joint maintenance projects and sponsorship of specific laboratory stations. Such collaboration is consistent with the wider quality assurance principle of connecting training provision with industry requirements [7, 13].

A fourth strategy is to align equipment proposals with established public intervention mechanisms. TETFund has provided for the upgrading of laboratories, workshops and equipment in universities, polytechnics and Colleges of Education (Technical), while its equipment-upgrade planning has emphasized assessment of institutional needs and prioritization of repair, replacement, rehabilitation and sustainable power requirements [15]. Polytechnics can therefore prepare evidence-based, phased equipment proposals that identify the competencies to be taught, the equipment required for each competency, estimated utilization, maintenance arrangements and measurable student outcomes. This makes drone maintenance equipment acquisition part of institutional quality assurance rather than an isolated procurement exercise.

The final strategy is lifecycle management. Institutions should budget not only for the initial purchase of training drones and diagnostic tools but also for spare parts, batteries, software updates, calibration, repairs, instructor training and safe storage. Equipment registers, preventive maintenance schedules and utilization records should be maintained. These measures can reduce premature equipment failure and provide evidence for future funding requests. In combination, phased procurement, shared facilities, industry collaboration, intervention funding and lifecycle management provide a more realistic pathway for introducing drone maintenance training within resource-constrained polytechnic environments.

5. Conclusion

Quality assurance in drone maintenance training is essential for developing a technically competent and sustainable workforce in Electrical/Electronic Engineering Technology education in polytechnics in South-South Nigeria. The findings indicate that effective drone maintenance training requires more than the inclusion of drone-related topics in the curriculum. It requires a comprehensive quality assurance system that encompasses relevant curriculum content, competent instructors, functional workshops, adequate tools and equipment, practical and competency-based training, appropriate assessment, industry collaboration, safety practices, regulatory compliance and continuous programme improvement. When these elements are effectively integrated, polytechnics can provide students with meaningful opportunities to acquire practical competencies that correspond with emerging technological and occupational demands.

The study further concludes that drone maintenance competencies represent an important emerging area of workforce development for Electrical/Electronic Engineering Technology students. Competencies in electrical and electronic fault diagnosis, battery management, motor and ESC maintenance, flight-controller configuration, sensor calibration, communication-system troubleshooting, preventive and corrective maintenance, post-maintenance testing and technical documentation can enhance graduates' capacity to function effectively in drone-related occupations and entrepreneurial ventures. Therefore, strengthening quality assurance in drone maintenance training can help bridge the gap between technical education and emerging industry needs, improve graduate employability and contribute to the development of an adaptable, innovative and sustainable technical workforce in South-South Nigeria.

6. Recommendations

Based on the findings of the study, the following recommendations are made:

1) Polytechnics in South-South Nigeria should establish and maintain a comprehensive quality assurance system for drone maintenance training that incorporates a current and industry-relevant curriculum, competent instructors, functional drone maintenance workshops, adequate diagnostic tools and equipment, competency-based practical assessment, safety procedures, regulatory requirements and continuous curriculum review.
2) Polytechnics should adopt phased procurement and shared-resource strategies for drone maintenance equipment. Priority should be given to high-utilization training drones, diagnostic instruments, battery-testing equipment, soldering and rework tools, programmable power supplies, measurement instruments, sensors and flight-controller training kits before expanding to more specialized equipment.
3) Polytechnics should strengthen partnerships with drone-related industries through equipment donations or loan schemes, joint practical demonstrations, industrial attachment, staff upskilling, maintenance projects and curriculum review. Such partnerships should be formalized through clear agreements that specify responsibilities for equipment use, safety, supervision and maintenance.
4) Institutional management should prepare evidence-based proposals to relevant intervention agencies, including TETFund, showing the competencies to be taught, equipment required, implementation phases, maintenance arrangements and expected student outcomes. Procurement should be accompanied by staff training, spare-parts planning, calibration and lifecycle maintenance.
5) Electrical/Electronic Engineering Technology programmes should deliberately develop and assess students' practical drone maintenance competencies in areas such as electrical and electronic fault diagnosis, battery and power-system maintenance, motor and ESC maintenance, flight-controller configuration, sensor calibration, communication and telemetry troubleshooting, preventive and corrective maintenance, post-maintenance testing and technical documentation. Such competency-based training should be supported with adequate practical exposure and industry-based experiences.

Abbreviations

DMMQ	Drone Maintenance Module Questionnaire
EET	Electrical/Electronic Engineering Technology
ESC	Electronic Speed Controller
NBTE	National Board for Technical Education
NCAA	Nigeria Civil Aviation Authority
Nig.CARs	Nigeria Civil Aviation Regulations
RPAS	Remotely Piloted Aircraft Systems
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
TVET	Technical and Vocational Education and Training
UAV	Unmanned Aerial Vehicle

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Conflicts of Interest

The author declares no conflicts of interest.

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