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Assessment of Optimal Use, Maintenance, Repair and Calibration of Radiation Monitoring Instruments in Nigeria

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Abstract

The response and performance of radiation detectors for accurate measurements and effective use for radiological safety in medical, industrial, and nuclear sectors are based on the optimal use, maintenance, repair and calibration of radiation monitoring instruments in a secondary standard dosimetry laboratory. In Nigeria, the suboptimal performances of these instruments are attributed to inadequate maintenance practices, insufficient calibration, and limited awareness of proper equipment handling for optimal use. This study assesses the current practices related to the optimal use, maintenance, repair, and calibration of radiation detection equipment across Nigeria's six geopolitical zones. Using a cross-sectional survey approach, data were collected from Ninety (90) radiation monitoring equipment operators, Radiation Safety Officers, and frontline responders to evaluate their knowledge, awareness, and practices concerning equipment usage, operation, storage, handling, and calibration. The findings reveal significant gaps in knowledge of usage (trained is 43.2%, not trained is 56.8%) and inconsistencies in maintenance practices (as indicated by the regression analysis ($\beta = 0.51$, $p < 0.01$), particularly regarding specialized instruments such as the PackEye, Mobile Detection System (MDS), Radionuclide Identinfinder (RID), and Personal Radiation Detectors (PRD). While there is high awareness of the need for regular calibration and handling training, the lack of standardized protocols and training alignment poses challenges to the effective use of these instruments. This study underscores the importance of comprehensive training programs, standardized maintenance protocols, and enhanced awareness initiatives to optimize the usage, performance and safety of radiation monitoring instruments in Nigeria.

Keywords

Radiation Monitoring Instruments, Detectors, Calibration, Radiation Safety Officers, PackEye, Radionuclide Identifinder, Personal Radiation Detectors

1. Introduction

Radiation monitoring instruments are essential tools for ensuring radiological safety and nuclear security in various practices, including medical, industrial, and nuclear energy sectors. These instruments, which consist of a detector medium, an electronic component, and a display unit, are designed to detect and measure radiation levels to prevent unnecessary exposure to ionizing radiation. Accurate knowledge of the usage and functioning of these instruments is critical for radiation safety; however, improper maintenance, poor storage, inadequate calibration, and poor handling can result in equipment failure, leading to inaccurate measurements, unexpected downtime, and potential radiation overexposure to workers and the public [1] [2].

The significance of maintaining radiation monitoring equipment cannot be overstated. Research indicates that many failures of radiation monitoring instruments are attributed to factors such as circuit board issues, wear and tear, improper use, manufacturing defects, and harsh environmental conditions [3] [4]. Equipment failure can also lead to substantial financial losses due to repair costs and the need for replacement, as well as safety risks in critical scenarios [5]. Studies have emphasized the importance of robust maintenance strategies and periodic calibration to mitigate these risks [6] [7]. However, in Nigeria, a lack of standardized maintenance practices and limited awareness of equipment handling among frontline officers and operators have contributed to the suboptimal performance of these instruments [8].

The International Atomic Energy Agency (IAEA) initiated the Coordinated Research Project J02014, which aimed at advancing the maintenance, repair, and calibration of radiation detection equipment globally, especially those deployed at the border and other strategic points to prevent illicit trafficking of nuclear and radioactive material. The assessment of performance, optimization, maintenance, repair, and calibration activities for radiation monitoring instruments mostly used for nuclear monitoring and security is very paramount. The users of equipment such as the PackEye, Mobile Detection System (MDS), Radionuclide Identifinder (RID), and Personal Radiation Detectors (PRD) in Nigeria, despite their widespread use, have a significant gap in knowledge regarding their usage, maintenance and calibration, which affects their response, reliability and effectiveness [2]. There is a major problem in ensuring the equipment performs to specification and expectation for a long period of time, if the users lack the theoretical knowledge of the operation of the detector

Previous studies have highlighted the importance of regular calibration and maintenance of radiation detection instruments to ensure accuracy and functionality [9] [10]. Tamura [11] constructed a POMDP model for maintenance action to analyse the properties of the optimal maintenance policy. However, a comprehensive understanding of the maintenance strategies and training needs among users in developing countries like Nigeria is lacking. The Secondary Standard Dosimetry Laboratory located at the University of Ibadan was established as a Technical Support Organization of the Nigerian Nuclear Regulatory Authority. It has traceability to IAEA primary Lab located at Siberdorf in Vienna, Austria. It ensures standardization of radiation measuring instruments in Nigeria through calibration using Cesium and X-ray source. The Institute has competent personnel who are experienced in the use and calibration of radiation-measuring equipment.

This paper presents the results of a survey conducted among radiation equipment users in Nigeria to evaluate their awareness and understanding of equipment operation, storage, handling, and calibration. The findings reveal critical gaps in knowledge and practices, underscoring the need for comprehensive training programs and standardized maintenance protocols to ensure the effective use of radiation monitoring instruments in the country.

2. Materials and Methods

A cross-sectional survey design was employed to evaluate the maintenance, repair, and calibration practices of radiation monitoring instruments across Nigeria's six geopolitical zones (South-South, South-East, South-West, North-Central, North-East, and North-West). The study targeted users of various radiation detection equipment mostly used for nuclear monitoring and nuclear security, including the PackEye, Mobile Detection System (MDS), Radionuclide Identifinder (RID), and Personal Radiation Detectors (PRD) as shown in **Table 1**. This design was chosen to capture the experiences and practices across diverse locations and operational environments.

Table 1. Equipment specifications and functions.

S/N	Equipment Name	Detection Medium	Sensitivity	Measuring Range	Energy Range	Radiation Type
1	Rapiscan Mobile Detection System (MDS)	Organic plastic scintillator (Gamma), He-3 tube (Neutron)	See below the table			Gamma, Neutron
2	Thermo Scientific Radeye PRD	NaI (Tl) scintillation detectors	150 cps/μSv/hr (Cs-137); 3000 cps/μSv/hr (60 keV);	0 to 250 μSv/hr; 0 to 800 kcps	30 keV to 1.3 MeV	Gamma
3	FLIR Radionuclide Identifinder (RID)	Nal; Geiger-Müller tube		0 μSv/h to 500 μSv/h (NaI); 100 μSv/h - 1 Sv/h (Geiger-Muller)	20 keV to 3 MeV	Gamma

Continued

4	PackEYE BackPack	Plastic scintillator (Gamma); Li-6 doped flat scintillation detectors (Neutron)	Greater than 3000 cps/microSv/h at 662 keV for gamma	0.05 to 26 μSv/hr (Gamma); 0.5 to 256 cps (neutron)	20 keV to 3 MeV (Gamma)	Gamma, Neutron

Sensitivity of MDS: 1) Gamma: Will detect 1000 g of 235U (HEU) and 10 g of 239 Pu in 20 uR/hr background at a passage speed of 5 mph (8 km/h), at a distance of 39 in (1 m); 2) Neutron: Will detect less than 200 g of plutonium in a shielded container that reduces the gamma flux to 1% of the unshielded gamma flux.

2.1. Data Collection

Data were collected using a semi-structured questionnaire administered to Ninety (90) radiation monitoring equipment operators, safety officers, and frontline workers across the six geopolitical zones (See **Appendix I**). The questionnaire, designed to capture both quantitative and qualitative data, was divided into four sections:

1) Demographic Information Collected: Basic demographic data such as age, gender, education level, and geographical location.

2) Awareness of Equipment Operation and Handling: Assessed respondents' awareness and understanding of the operation and handling of radiation detection instruments.

3) Knowledge of Equipment Specifications and Functions: Gathered information on the technical knowledge of the equipment, including sensitivity, detection range, and calibration intervals.

4) General Knowledge and Maintenance Practices: Explored overall knowledge of maintenance practices, storage conditions, calibration procedures, and common faults.

Data collection occurred from March to May 2024, with face-to-face interviews conducted to clarify responses and gather in-depth qualitative insights.

2.2. Data Analysis

The quantitative data were analyzed using SPSS version 26.0, employing descriptive statistics (frequencies, percentages, means, standard deviations) to summarize demographic characteristics and levels of awareness, knowledge, and maintenance practices. Inferential statistics, including chi-square tests, were used to examine associations between demographic variables and knowledge or awareness levels. Cross-tabulation identified patterns in maintenance practices across different zones.

Qualitative data from open-ended questions and interviews were analyzed thematically, with responses coded to identify emerging themes related to maintenance challenges, training needs, and optimization strategies.

3. Results

3.1. Demographic Data

Results of the evaluation of the demographic data revealed that there were 10% (9) female and 90% (81) male from the 90 respondents. The range of their ages in percentage was represented in **Figure 1** (pie chart) below. Responses were obtained from different locations in the six geopolitical zones across the country as shown in **Table 2**.

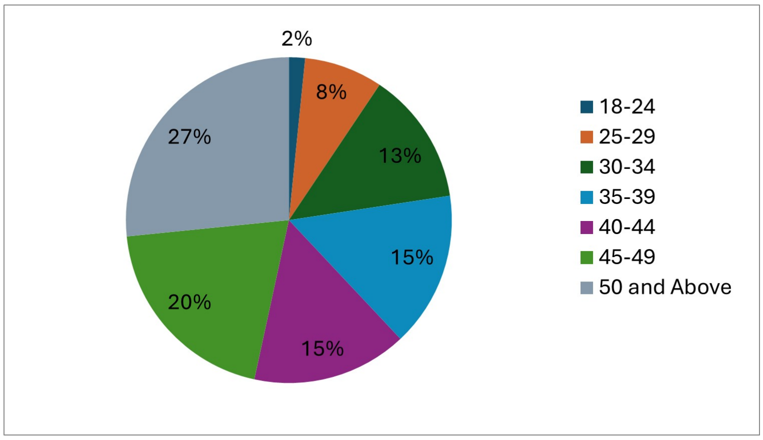

Figure 1. Percentage for age ranges.

Table 2. Operational locations.

REGION	OPERATIONAL LOCATIONS	POPULATION	% POPULATION
	Port Harcourt	16	17.9
SOUTH-SOUTH	Bonny	4	4.5
	Delta	16	17.9
	Edo	3	3.4
SOUTH-WEST	Lagos	13	14.6
	Ogun	4	4.5
	Ibadan	5	5.6
	Ekiti	2	2.3
NORTH-CENTRAL	Abuja	8	8.9
	Plateau	2	2.3
NORTH-WEST	Kano	3	3.4
	Katsina/Kaduna	4	4.5
	Sokoto	2	2.3
NORTH-EAST	Adamawa/Yobe/ Maiduguri/Gombe	4	4.5
SOUTH-EAST	Enugu	3	3.4

3.2. Awareness of Equipment Operation and Handling

This session detailed the respondent's awareness of the equipment operation, calibration procedure, training needs, and handling responsibilities.

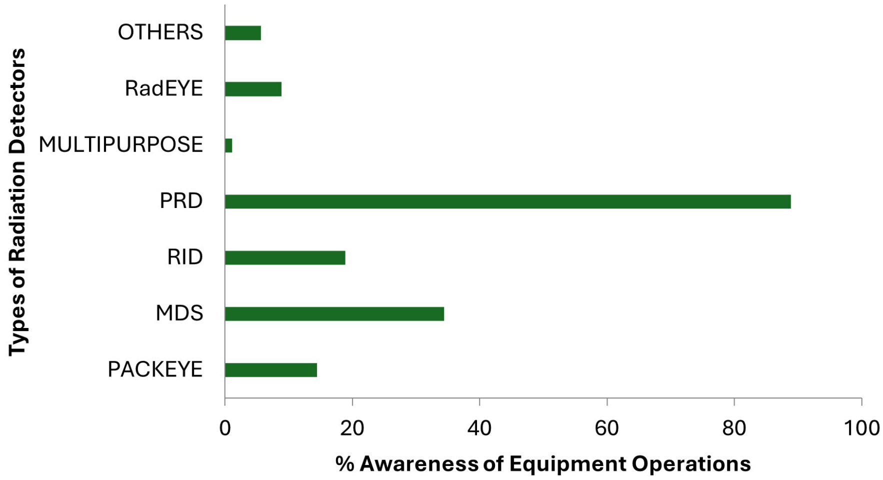

Figure 2. % Awareness of equipment operation.

The bar chart in Figure 2 presents the respondents' awareness of the equipment operations. It shows that 88.9% of users are aware of the operation of PRD while 1.1% of the users can operate a multipurpose detector.

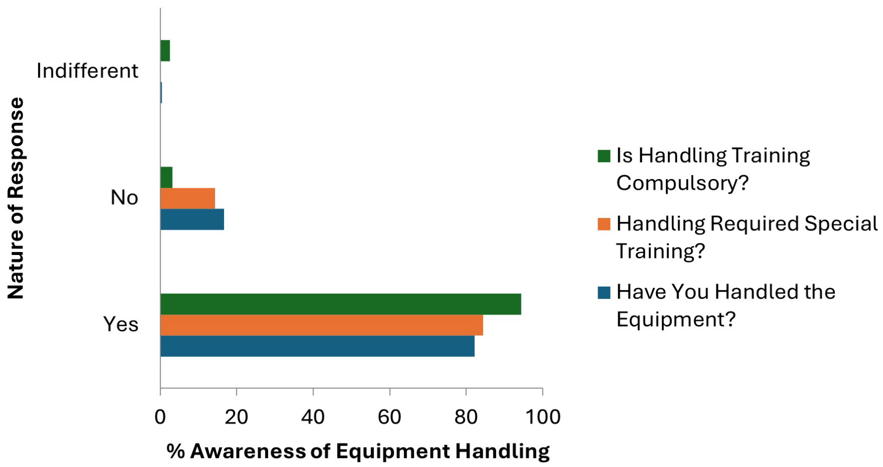

Figure 3. % Awareness of equipment handling.

From Figure 3, averagely 89% of users have an awareness of handling and use of detectors through regular training, which was made compulsory for everybody, while 83% believed that handling requires some specialized training. Less than 20% have not handled the detector at all.

Figure 4 presents the type and level of training acquired by the respondent, which shows that 64% of users had basic knowledge of training, 23% had intermediate and 13% had advanced training on the use of the equipment. While 43%

had undergone basic training, only about 30% had undergone intermediate or advance training.

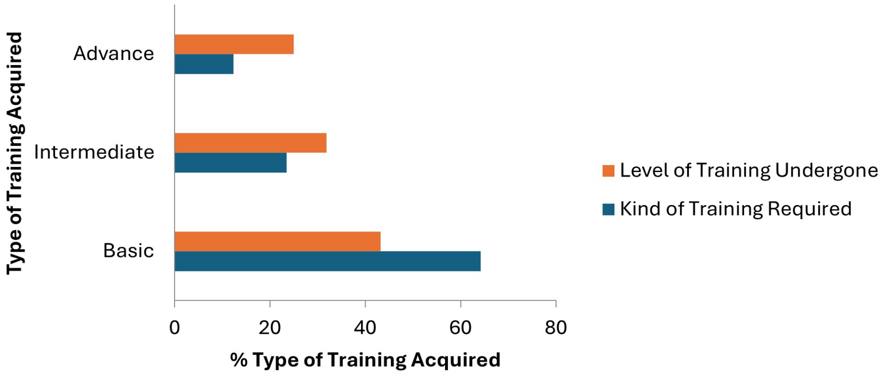

Figure 4. % Type and level of training acquired.

Figure 5 presents general awareness of radiation equipment while Figure 6 summarized knowledge of equipment specifications and functions.

It is shown in Figure 5 that 86% of the users had a general awareness of the equipment with descriptions, while only 14% had a general awareness with examples.

Respondents showed good knowledge of the technical specifications and detection capabilities of these devices, particularly the RID (87% agreement) as represented in Figure 6.

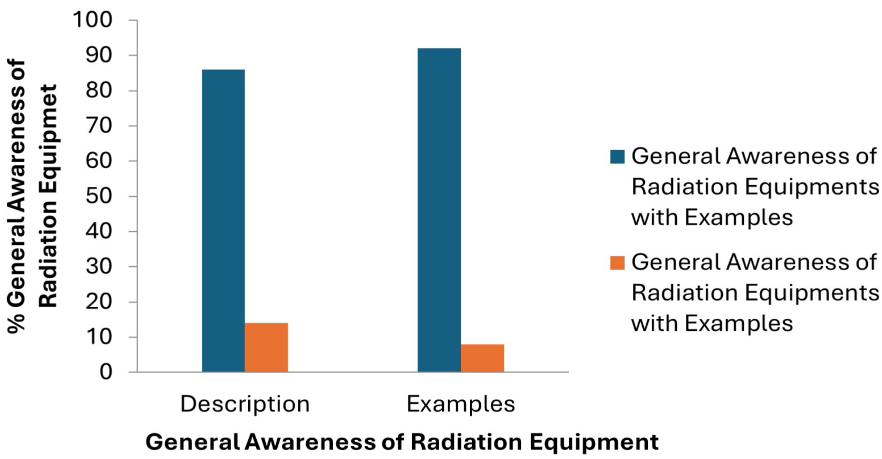

Figure 5. General awareness of radiation equipment with description and examples.

Table 3 presents the awareness of the respondents as to who should handle radiation equipment, and it shows that Radiation Safety Officers (RSOs) are viewed as the most qualified personnel to handle radiation equipment (40%).

Table 4 presents the awareness of equipment storage knowledge, and it shows that 35.5% are of the view that the equipment should be stored in a warehouse, a safe and secure place.

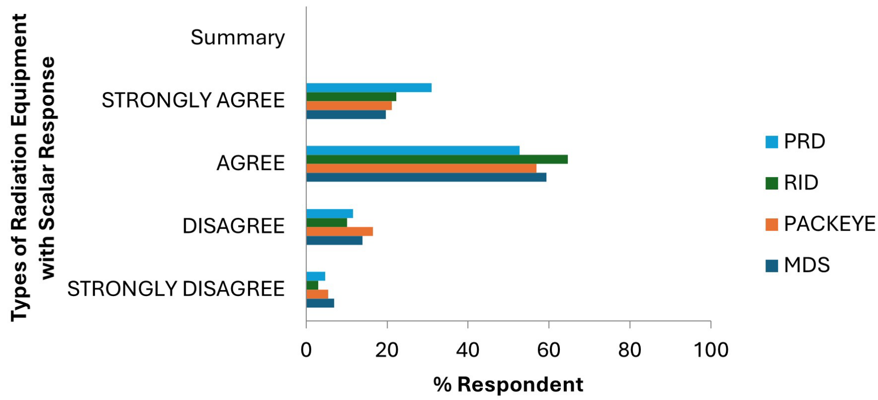

Figure 6. % Summary of knowledge of equipment specifications and functions.

Table 3. Awareness of who should handle radiation equipment.

S/N	PERSONNEL THAT SHOULD HANDLE THE EQUIPMENT	RESPONDENT	% RESPONDENT
1	Radiation Safety Officer (RSO)	36	40
2	Trained and Certified Personnel	26	28.9
3	Classified Radiation Workers	15	16.7
4	Operators/Radiographers	8	8.9
5	Medical Physicists	5	5.5

Table 4. Awareness of equipment storage in the facility.

S/N	LOCATION FOR EQUIPMENT STORAGE	RESPONDENT	% RESPONDENT
1	In the Instrumentation room	2	2.2
2	In a warehouse, safe and secured place	32	35.5
3	In the equipment box/case	5	5.6
4	In a Bunker, well shielded area	25	27.8
5	In a Controlled Area	21	23.3
6	In the office of RSO/Medical Physicists	5	5.6

Table 5 presents the awareness of procedure for calibration, which shows that awareness of calibration procedures is moderate (69.1%), but the remaining 30.9% either lack awareness or report no procedures.

The questionnaire also assesses the Knowledge of Equipment Specifications and Functions for MDS, PACKEYE, RID and PRD. (See **Appendix I**)

4. Discussions

The demographic data highlight a significant gender imbalance (90% male) and

Table 5. Awareness of procedure for calibration of equipment.

	YES	NO
Is there a procedure in place for regular calibration of equipment?	56	26
%	69.1	30.9

an aging workforce predominantly aged 45 and above, indicating the need for more inclusive recruitment strategies and succession planning. Geographically, respondents are concentrated in the South-South and South-West regions of Nigeria, revealing gaps in operational reach and awareness in the North-East and North-West. This uneven distribution suggests the need for targeted efforts to ensure uniform knowledge and capability across all regions.

Awareness levels vary significantly across different radiation detection equipment. While the Personal Radiation Detector (PRD) shows high awareness (88.9%), specialized equipment like the Multipurpose detector (1.1%), as represented in **Figure 2**, has lower awareness, indicating a need for more focused equipment training. The majority of respondents (83.3%), as indicated in **Figure 3**, have experience handling radiation equipment, aligning with global best practices that emphasize rigorous training. However, some respondents (16.7%) lack this experience, highlighting operational access constraints.

From **Figure 4**, the result reveals that there are notable gaps between the type and level of training required versus the training received with only 43.2% of respondents having received intermediate or advanced training necessary for the safe and effective handling of radiation detection equipment. Regression analysis reveals that training is a significant predictor of proper maintenance practices ($\beta = 0.51$, $p < 0.01$). This finding underscores the potential of targeted training interventions to enhance equipment maintenance and reduce failures. While prior studies have emphasized the importance of training [7], this study provides quantitative evidence of the direct impact of advanced training on maintenance outcomes.

There is a stark contrast between general awareness (86% with descriptions) and awareness with specific examples (14%), as shown in **Figure 5**, suggesting that theoretical knowledge does not always translate into practical understanding. This gap highlights the importance of practical, example-based training to ensure effective practice in radiation detection. The training programs should include verification of equipment, calibration and advanced handling techniques. This insight is particularly relevant for regulatory bodies like the Nigerian Nuclear Regulatory Authority (NNRA) and international agencies like the IAEA, which could use these findings to design more effective training curricula tailored to the specific needs of operators in Nigeria and similar settings. Radiation Safety Officers (RSOs) are viewed as the most qualified personnel to handle radiation detection equipment (40%), as represented in **Table 3**, but there is a need to diversify training to include other classified personnel that might be involved in the use of these detectors. This broader approach would enhance operational flexibility and resilience.

Diverse opinions on storage practices suggest a lack of standardized information and protocols, which could lead to safety risks or inefficiencies. Comparing these findings with the literature, the low awareness of proper storage practices is particularly concerning. According to [9], improper storage of radiation detection instruments can lead to equipment degradation, inaccurate readings, and increased exposure risks. This study corroborates that equipment storage remains a critical yet overlooked component of radiation safety management. Similarly, as represented in **Table 5**, awareness of calibration procedures is moderate (69.1%), but the remaining 30.9% either lack awareness or report no procedures, indicating a need for consistent policies and training to ensure equipment reliability.

The knowledge of equipment specifications and functions, such as the Mobile Detection System (MDS), PackEye, Radionuclide Identifinder (RID), and Personal Radiation Detector (PRD), was also relatively high. Respondents showed good knowledge of the technical specifications and detection capabilities of these devices, particularly the RID (87% agreement), as represented in **Figure 6**. This aligns with the findings of [10] who reported that understanding the functionality of radiation detection instruments is essential for effective deployment and usage. The strong correlation between knowledge of equipment specifications and effective maintenance practices ($r = 0.62$, $p < 0.01$) highlights the need for enhanced training programs that focus on both technical knowledge and practical application. This study provides new insights into the importance of technical knowledge as a determinant of proper maintenance and safety protocols. This connection suggests that increasing technical knowledge could enhance maintenance practices, reduce equipment failures, and improve overall radiation safety.

5. Recommendations

1) There is a need to bridge the critical gap in knowledge of usage, training, and standardized procedures.

2) Standardized maintenance protocols should be developed by the competent Authority and significant disparities in training needs versus training received should be itemized.

3) Training programs should be focused on specific equipment types, such as MDS, PACKEYE, and RID. This is essential to bridge these existing gaps between frontline responders and radiation safety officers.

4) Purposely built storage facilities should be made available at every facility of operators and calibration practices across different regions and facilities are crucial for minimizing safety risks and enhancing operational efficiency.

5) There is a need for the establishment of consistent guidelines for storage handling.

6) Implementation of region-specific and role-specific awareness programs to ensure uniform knowledge and skills distribution among all relevant personnel, especially in underrepresented regions, should be considered, and policies that

mandate standardized training and certification for all users of radiation detection equipment, supported by regular audits and compliance checks should be implemented.

7) Management of operators and users of radiation measuring equipment should have an inclusive workforce Planning and Diversity that promotes gender and age diversity in recruitment and training strategies to build a more sustainable and effective radiation safety management system.

6. Conclusion

This study has revealed that users of radiation measuring equipment in Nigeria lack the necessary understanding of the storage and maintenance of the equipment with which they are familiar. It also shows that there is an existing gap in practical training for optimal performance. It provides valuable insights into the performance, maintenance, repair, and calibration practices of radiation monitoring instruments in Nigeria, highlighting critical gaps in knowledge, training, and standardized procedures. The data indicate that while there is a general understanding of the importance of regular calibration and handling training, there is a lack of standardized maintenance protocols and significant disparities in training needs versus training received. By addressing the above recommendations, the reliability, accuracy, and safety of radiation monitoring instruments would be improved, thereby enhancing radiological protection and safety management across Nigeria.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix I: Research Questionnaire

CRP J02014: ADVANCING MAINTENANCE, REPAIR AND CALIBRATION OF RADIATION DETECTION EQUIPMENT

RESEARCH CONTRACT TITLED "PERFORMANCE ASSESSMENT AND OPTIMIZATION OF MAINTENANCE, REPAIR AND CALIBRATION ACTIVITIES FOR RADIATION MONITORING INSTRUMENTS IN NIGERIA."

This questionnaire is specially designed for research purposes; as such, the information supplied will be treated as confidential. Please feel free to give honest information as it applies to you.

Thank you for your co-operation,

INSTRUCTION:

Kindly tick (√) where necessary and complete with possible answers where applicable.

SECTION A (DEMOGRAPHIC DATA)

1) SEX: Male ( ) Female ( )
2) AGE: 25 - 29 ( ) 30 - 34 ( ) 35 - 39 ( ) 40 - 44 ( )
 45 - 49 ( ) 50 & above ( )
3) YEARS OF EXPERIENCE: 1 - 5 ( ) 6 - 9 ( ) 10 - 14 ( )
 15 - 19 ( ) 20 - 24 ( ) 25 - 29 ( ) 30 & Above ( )
4) LOCATION

SECTION B (AWARENESS OF EQUIPMENT OPERATION AND HANDLING)

5) Which of this equipment have you seen or heard of?
 PackEye [ ] MDS [ ] RID [ ] PRD [ ]
6) Have you handled or worked on any of the equipment before?
 1. Yes ( ) 2. No [ ] 3. Indifferent [ ]
7) Does handling the equipment require any special training?
 1. Yes [ ] 2. No [ ] 3. Indifferent [ ]
8) If yes to the above question, what kind of training is required for handling and proper functioning of the equipment?
 1. Basic [ ] 2. Intermediate 3. Advanced [ ]
9) What level of training have you undergone recently?
 1. Basic [ ] 2. Intermediate 3. Advanced [ ]
10) Is it a requirement that anyone handling equipment in your facility must be trained?
 1. Yes [ ] 2. No [ ] 3. Indifferent [ ]
11) In your own opinion, what do you understand by radiation equipment with

examples?

12) Have you ever heard of Pack Eye, Mobile Detection System, Radiation identifinders and personal radiation detector?
    1. Yes [ ] 2. No [ ]
13) In your own opinion, who should handle this equipment?
14) How is the equipment stored or preserved in your facility?
15) What are common faults noticeable that can affect the reliability of the equipment?
16) Can you say the equipment is durable and reliable? (Make suggestions on improvement)
17) How is the accuracy of the equipment evaluated by the handlers or users?
18) Is there any procedure for request, use and return of radiation equipment?
19) Is there a protocol to check the equipment status after use?
20) Is there a procedure in place for regular calibration of equipment? (Please comment)
21) Who is the equipment specifically designed for?

SECTION C (KNOWLEDGE OF EQUIPMENT SPECIFICATION AND FUNCTIONS)

Kindly tick (√) where it applies to you
SD: STRONGLY DISAGREE
D: DISAGREE
A: AGREE
SA: STRONGLY AGREE

	MOBILE DETECTION SYSTEM (MDS) SCALE	SD	D	A	SA
22	I am aware MDS is a tool to survey large contaminated area				
23	MDS involves using air to discover localized hot spots and map the event				
24	It can easily be deployed in any type of moving vehicle to search for unusual or abnormal radioactivity				
25	It comprised a large volume, highly sensitive organic plastic scintillator detector				
26	The data is stored in a .dbf file, which can be easily exported to other programs				
27	MDS uses MAPTRACK, a standalone software program that helps load any type of standard commercial or military maps				
28	MDS is an ideal search and discover tool that may be utilized by nearly anyone with very little training required				
29	The system contains a battery that when fully charged provides 8 hours of continuous use				
30	External power capability is present with both AC and DC Adapters				

Continued

31	The MDS has been designed for civilian and military responders				
32	It is the mobile detection solution for those who need fast, dependable threat assessment for tactical operations involving radiation				
33	It is a proactive surveillance which measures and also searches out and locates stolen/lost radiation sources				
34	The MDS has been successfully tested and adopted by other military personnel for use on their FOX reconnaissance vehicles				
35	The MDS has also successfully been deployed in helicopters, emergency vehicles and by secret service agencies				
	PACKEYE SCALE	SD	D	SA	A
36	PackEye is necessary to detect radiological contamination				
37	PackEye has nothing to do with radiation of any kind				
38	It helps locate gamma emitting radioactive source in large areas rapidly				
39	Fast detection and locating of radioactive sources via high sensitivity plastic detector				
40	It ensures maximum sensitivity through automatic adjustment to background variations				
41	Its user-friendly interface with simple LED level, alarm and status indication including NBR feedback (red and green)				
42	It makes use of unchallenged light weight of 7.5 kg				
43	The power consumption of PackEye is low				
44	Its operation time 30 hr (20 hr with Bluetooth™ data transfer to optional PDA)				
45	Prone to error by handlers				
46	Both the professional and non-professional can handle it				
	RADIATION IDENTIFINDERS				
47	They quickly locate and measure radioactive sources with confidence				
48	They deliver rapid radioisotope identification to reduce time to action and expedite response measures				
49	They offer increased sensitivity, flexible power management, and industry-leading communication features				
50	It is a secondary verification tool to deliver the spectroscopic information needed to identify a specific nuclide				
51	They deliver rapid isotope identification against the ANSI N42.34 library for threat determination				
52	They are a great choice for security teams to distinguish between true threats and benign sources without disrupting the flow of an event where there is large gathering				
53	It helps to separate innocent sources such as medical personnel from potential threats				

Continued

54	Multi-layer approach is required for physical security to be effective				
	Personal Radiation Detectors (PRD) Scale	SD	D	SA	A
55	Its small electronic devices are used to detect the illicit transport of radioactive materials				
56	It is also known as radiation pagers				
57	They are used for screening during patrols or at events				
58	Most PRDs provide a digital display of the exposure rate and a visual, auditory, or vibratory alarm at preset thresholds				
59	Designed to be clipped to the wearer's belt, weigh less than a pound, and use battery power				
60	They generally employ scintillation technology to detect gamma radiation				
61	The devices have separate indicators to show if neutrons are detected				
62	PRDs alert the wearer of the presence of radioactive material				
68	It can be used to interdict the illicit movement of radioactive material				
69	PRDs are one of several complementary radiation measurement devices used in interdiction missions				
70	It makes use of scintillators containing lithium to indicate the presence of neutron radiation				

SECTION D: GENERAL KNOWLEDGE

Discussion Guide

1) In your own opinion, what do you understand by radiation equipment with examples?
2) Have you ever heard of Pack Eye, Mobile Detection System, Radiation identifinders and personal radiation detector?
3) In your own opinion, who should handle this equipment?
4) How is the equipment stored or preserved?
5) What is a common fault noticeable that can affect the reliability of the equipment?
6) How is the durability of this equipment measured?
7) How is the accuracy of the equipment evaluated by the handlers or users?
8) Who is the equipment specifically designed for?