INDUSTRIAL RADIOGRAPHY IN NIGERIA; AWARENESS AMONG RADIOGRAPHY STUDENTS IN UNIVERSITY OF BENIN,EDO STATE, NIGERIA

A PROJECT

BY

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MATRICULATION NUMBER: BMS1902571

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SCHOOL OF BASIC MEDICAL SCIENCES,

UNIVERSITY OF BENIN,

BENIN CITY

MARCH, 2025

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A PROJECT WORK SUMMITED TO THE DEPARTMENT OF RADIOGRAPHY, SCHOOL OF BASIC MEDICAL SCIENCES, UNIVERSITY OF BENIN,

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR's DEGREE OF RADIOGRAPHY (B.Rad)

MARCH, 2025

CERTIFICATION

This is to certify that this project work with the topic: **INDUSTRIAL RADIOGRAPHY IN NIGERIA; AWARENESS AMONG RADIOGRAPHY STUDENTS IN UNIVERSITY OF BENIN by Obaseme dominion Osemuahu** with matriculation number **BMS1902571** was carried out under my supervision.

DR G.E OKUNGBOWA **……**

(Supervisor) **Signature and date**

Mrs F. O. Igbinedion **……..**

Head of Department ***Signature and Date***

DEDICATION

This project work is dedicated to God almighty who has always been in control in my academics, also to my lovely mum and brother.

ACKNOWLEDGEMENT

I would like to express my special thanks and gratitude to my project supervisor (Dr. Okungbowa, G. E.) for his support and guidance in completing my project work and also to my HOD (Mrs igbenidion), department staff, my family and loved ones.

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ABSTRACT

Background: Industrial radiography is a crucial non-destructive testing method that ensures the safety and integrity of industrial infrastructure. Despite its importance, awareness and adoption of industrial radiography as a career path among radiography students remain underexplored, particularly in Nigeria.

Aim: This study investigates the awareness of industrial radiography among radiography students at the University of Benin, Nigeria. It examines their awareness levels, sources of information, attractors, detractors, and perceptions of industrial radiography as a career option.

Method: A cross-sectional survey design was used, a self constructed questionnaire was used in collecting data from 266 radiography students. Descriptive statistics and chi-square tests were applied to analyze the data, assessing relationships between awareness and various demographic and academic factors.

Results: 69.5% of students were aware of industrial radiography, with media (38.4%) and lectures (32.4%) being the primary sources of information.

- 79.7% believed industrial radiography was not adequately covered in their curriculum.

The key attractors to the field were the opportunity to work in an industry (29.3%) and improved remuneration (29.3%), while the main detractors were a preference for medical radiography (30.1%) and fear of radiation hazards (25.6%).

Despite 82.3% perceiving industrial radiography as a prestigious career, 89.1% felt it was not a popular career choice in Nigeria.

- Chi-square tests showed a significant relationship between age group and awareness ($p = 0.004$) and between awareness of industrial radiography as a career and general awareness ($p < 0.001$).

No significant relationships were found between gender, level of study, curriculum coverage, or perception of prestige and awareness levels.

Conclusion: While awareness of industrial radiography is relatively high, significant gaps exist in curriculum coverage and practical training. The study recommends integrating industrial radiography into the curriculum, fostering university-industry collaborations, and conducting awareness campaigns to promote industrial radiography as a viable career option. These steps are essential for developing a skilled workforce to enhance the safety and integrity of Nigeria's industrial infrastructure.

CHAPTER ONE

1.1 BACKGROUND OF STUDY

Two of the giant strides in radiography was the discovery of x-ray by Wilhelm Conrad Roentgen in 1895 and after which following 3 years, radioactive source (Radium) was discovered by Henry Becquerel. The discovery of these two types of radiation by two scientists gave rise to industrial Radiography (Patrick, 2008).

Industrial radiography is a non-destructive testing (NDT) technique that utilizes ionizing radiation to inspect materials for internal defects, ensuring structural integrity without causing damage to the object under examination (Busberg et al.,2012).It is widely employed across various industries, including manufacturing, aerospace, construction, oil and gas, and automotive. The vast majority of industrial radiography concerns the testing and grading of welds on pressuring piping, pressure vessels, high-capacity storage containers, pipelines and some structural welds, machine parts, plate metal, concrete (Patrick,2008). Industrial Radiography is a key tool for quality control, safety, and reliability and is widely used to assess the structural integrity of equipment and materials without meddling with their usefulness (Agbo,et.al 2024).

Industrial radiography primarily uses two sources of radiation, which are X-rays and gamma rays. The typical gamma ray source is composed of a gamma ray-impermeable metal capsule that contains a radioactive element and is provided with a window in the desired position to be opened when radiation is desired. Typical gamma ray sources are such artificially radioactive elements as cobalt 60, iridium 192, cesium 137, and thulium 170 (Fujifilm, 2020). Gamma rays are more penetrating than X-rays, making them suitable for inspecting thick materials like steel like pipes.

This method is portable, ideal for field inspections or remote areas without electricity.

Industrial radiography has undergone significant advancements, transitioning from traditional film-based methods to cutting-edge technologies such as digitization, computed radiography, and direct radiography. These innovations have substantially enhanced image acquisition, streamlined workflows, and reduced costs associated with film purchasing and manual processing. Despite its advantages, industrial radiography presents significant safety challenges, particularly in difficult working conditions and environments. Radiographs may be performed in scenarios that pose risks of accidental exposure, necessitating rigorous adherence to site working rules. Personal monitoring records reveal that doses received by operators in industrial radiography are among the highest in any group of radiation workers (Arpansa, 2018). Historical accidents have resulted in severe health consequences, including radiation burns and fatalities due to equipment malfunctions (Yildiz & Pecky, 2019).

A comprehensive safety program is crucial in industrial radiography to minimize risks and ensure safe operation. The technique's high-energy nature presents specific challenges for practitioners inspecting critical components and structures, underscoring the need for stringent safety protocols (Patrick,2008)

Occupational radiation exposure (ORE) remains a significant concern in radiography. The International Commission on Radiological Protection (ICRP) recommends that the annual effective dose for radiation workers not exceed 20 mSv (ICRP, 2018). Understanding ORE is vital for developing safety protocols that minimize health risks associated with radiation exposure.

Regular monitoring of radiation doses is essential, and common methods include film badges, thermo-luminescence dosimeters (TLD), and pocket dosimeters (Banerjee, 2015). Industrial

radiographers play a critical role in ensuring safety for themselves, their colleagues, and the public. They must attain a recognized level of competence through formal training and ongoing education in radiation safety and technology. Compliance with safety regulations and the use of dosimeters to monitor exposure are essential to their practice (IAEA, 2011).

Career awareness typically develops during late adolescence, as high school students become increasingly conscious of social expectations and begin exploring career options. Herr and Johnson (1989) emphasize that effective career exploration requires students to actively seek information about various choices, understand their own skills and values, and discover educational opportunities (Ibrahim et al.,2015). The absence of adequate counseling and awareness initiatives in secondary schools is a critical factor contributing to the low enrollment of Nigerian students in professional fields such as radiography and engineering. The Council for Education Policy, Research and Improvement (CEPRI, 2004) in the UK identified career awareness as a crucial area needing enhanced focus and resources to improve educational effectiveness (Ibrahim et al.,2015).

Awareness of industrial radiography encompasses the understanding of its principles, techniques, and applications. This includes knowledge of how radiographic methods are employed for non-destructive testing (NDT) in various industries, as well as an understanding of safety protocols and regulatory standards that govern the practice.

The significance of awareness in industrial radiography cannot be overstated. As noted by (Wylie et al. 2019), effective training and education in radiography are essential for ensuring safety and reliability in industrial applications. A well-informed radiographer is critical for maintaining quality control and ensuring compliance with industry standards. Furthermore, a

lack of awareness can lead to improper use of radiographic techniques, resulting in potentially dangerous situations or costly errors (Smith & Jones, 2020).

This study aims to assess the knowledge and awareness of industrial radiography profession among students at the University of Benin and explore strategies to enhance this awareness. Such initiatives are essential for aligning students' interests and strengths with career opportunities, thereby promoting individual achievement and community prosperity. Furthermore, UNESCO (2008) emphasizes that effective career awareness supports students in making informed educational choices, ultimately contributing to personal development and reducing unemployment rates.

1.2 STATEMENT OF PROBLEM

In spite of the increasing need for non-destructive testing (NDT) methods in Nigeria's industry, the majority of radiography students are not well aware and knowledgeable about industrial radiography, which prevents the establishment of a skilled workforce to satisfy industry demands. The dominance of university programs with curricula including medical radiography courses excludes industrial radiography so much that it exposes students very little to principles and applications of industrial radiography, insufficient exposure and practice in conducting NDT, low knowledge regarding the application of industrial radiography in quality assurance, safety, and infrastructure creation.(Agbo et.,al 2024)

Consequently, this ignorance exposes Nigeria's industrial growth to risk because: unavailability of qualified radiographers inhibits industrial growth, poor quality control compromises product integrity limited ability constrains efficient inspection and maintenance. (Agbo et.,al 2024)

There have been researches done in the majority of regions in the world to access industrial radiography awareness levels amongst Radiography students but with a shortage of information in our region Edo state, Nigeria.

1.3 AIM AND OBJECTIVE OF THE STUDY

The aim of this study is to assess the awareness of industrial radiography among Radiography students in university of benin

The Objective are:

- To evaluate the current level of knowledge about industrial radiography among radiography students.
- To assess the perception of industrial radiography as a potential career path among radiography students.

1.4 SIGNIFICANCE OF STUDY

Industrial Radiography in Nigeria: Awareness among radiography students in university of benin is important for several reasons.

- Findings of the research will be used to plan and revise curricula to confirm that radiography education in Nigeria equips the students adequately to pursue industrial radiography careers.
- The study emphasizes practical training and cooperation between education institutions and the industry, with the purpose of encouraging partnerships to enhance students' practical experience.
- By promoting industrial radiography awareness, the research can inspire students to pursue professional occupations within the field, further increasing Nigeria's industrial radiography market.

1.5 RESEARCH QUESTIONS

1. What is the level of awareness of industrial radiography among radiography students at the University of Benin?

2. How is the perception of industrial radiography as a potential career path among Radiography students

3. What is the resources and learning opportunities available to students regarding industrial radiography within the university curriculum

1.6 HYPOTHESES

Null Hypothesis (H0) : There is no significant difference in the level of awareness of industrial radiography between Radiography students in 100L, 200L, 300L, 400L, and 500L at the University of Benin.

Alternative Hypothesis (H1): There is a significant difference in the level of awareness of industrial radiography between Radiography students in 100L, 200L, 300L, 400L, and 500L at the University of Benin.

1.7 SCOPE OF STUDY

This study focuses specifically on radiography students in year 1 to year 5 class at the University of Benin,Edo State, Nigeria

1.8 OPERATIONAL DEFINITION OF TERMS

1. Industrial Radiography: Industrial radiography is a form of non-destructive testing that uses ionizing radiation to inspect materials and components in order to locate and identify defects and degradation in material properties that may lead to the failure of components and engineering structures.

2. Radiography Students: Undergraduate students enrolled in the Radiography program at the University of Benin, Nigeria.
3. An industrial radiographer: is a professional who uses radiographic techniques to inspect materials and structures for quality and integrity. This role primarily involves the application of X-rays or gamma rays to detect flaws, such as cracks, voids, or other imperfections in metals, welds, and composites.

CHAPTER TWO

LITERATURE REVIEW

Industrial radiography, a non-destructive testing method, plays a vital role in ensuring the integrity and safety of industrial infrastructure in Nigeria. However, the awareness and knowledge of industrial radiography among radiography students in Nigeria remain unclear. This study aims to investigate the level of awareness and factors influencing industrial radiography awareness among radiography students in Nigeria.

2.1 CONCEPTUAL FRAMEWORK

2.1.1 Safety in industrial radiography

Design and Use of Shielded Enclosures

Shielded enclosures are critical for industrial radiography, providing protection from ionizing radiation. Their design varies based on the type of radiation used, ensuring worker safety and limiting exposure to 5 mSv or less per year. (Razak et al.,2023)

A supervised area surrounding the enclosure must be clearly marked and monitored to assess safety conditions. The design should adhere to ALARA principles, minimizing radiation exposure. Access is controlled through administrative measures, such as permit systems and locked or interlocked doors, proportional to expected radiation levels. (Razak et al.,2023)

Site Radiography Procedures

On-site radiography must consider factors like location, weather, and obstacles. A controlled area is established with boundaries and monitored by a safety officer. Warning signs are necessary to inform workers of radiation risks, and regular patrols ensure unauthorized access is prevented. (Razak et al.,2023)

Monitoring

Monitoring is essential for tracking radiation exposure. Workers must wear personal dosimeters and check them after tasks to ensure limits are not exceeded. Personal alarm monitors and portable survey meters are also used to assess radiation levels, and all activities involving radiation must be documented for safety. (Razak et al., 2023)

Emergency Response Planning

Despite strict procedures, accidents can occur, necessitating a robust emergency response plan. Key roles include the response initiator, who manages immediate actions; the emergency manager, responsible for overall response and resource allocation; and the radiological assessor, who conducts surveys and provides protection recommendations. These roles work together to minimize the impact of any emergency. (Razak et al., 2023)

2.1.2 Requirement applying to operators of industrial radiography

While the primary responsibility for radiation safety lies with the Responsible Person, operators have a responsibility to work safely in accordance with this Code and the working rules and work practices to be followed as detailed in the Radiation Management Plan approved by the Responsible Person. Operators are expected to undertake all reasonable actions to restrict their own exposure and those of other workers and members of the public

General requirements

The operator must ensure that:

they comply with the Radiation Management Plan approved by the Responsible Person, including any working rules, work practices to be followed, and emergency proceed

prior to commencing industrial radiography work, all interlocks, shielding, collimators, signs,

barriers and other protective devices are properly positioned at all times during industrial radiography work they wear a personal radiation monitoring device, approved by the relevant regulatory.

The following details of the movement of exposure containers and radiation generators are legibly entered in a radiation source movement book;

i. The identification number of the exposure container or radiation generator

ii. For exposure containers, the sealed radioactive source involved and its activity at the time of transfer

iii. The location of sites where the exposure container or radiation generator is to be used

iv. The date and time of removal from the radiation store

v. the estimated date and time of return to the radiation store

vi. the date and time of return to the store

vii. the name of the operator

on removing an exposure container from the store, they verify that the sealed radioactive source has been transferred to their custody by checking the exposure rate from the exposure container with a radiation survey meter and record this fact in the radiation source movement book(Australian Radiation Protection and Nuclear Safety Agency. (2018).

2.2 THEORETICAL REVIEW

2.2.1 Structures of industrial x-ray films

X-ray films for industrial radiography consist of an emulsion and a bluetinted base of polyester 175μ thick. The emulsion is coated on both sides of the base in layers and protected on both sides

with thin outer protective layers. The emulsion consists of silver halides as the photosensitive material, additives and gelatin. The silver halides form an image when influenced by X-rays, gamma rays, secondary electrons or fluorescent light. In films for general photography the emulsion is coated only on one side of the base, whereas it is coated on both sides for industrial radiography. The absorption of highly-penetrative X-rays or gamma rays is increased by using two emulsion layers so that the photosensitive silver compound is utilized more effectively for the absorption of radiation and electrons. Furthermore, the two emulsion layers also help to increase the contrast and image density of the radiograph (Fujifilm,2020)

2.2.2 Industrial radiography installation

Enclosed Radiography: The following requirements in respect of enclosed radiography shall be complied with:

The room housing of shall be in a location where the occupancy is as low as practicable and shall be located in industrial area.

The enclosed radiography installation shall provide adequate structural shielding for walls/doors, ceiling and floor so that the radiation levels outside the shielding do not exceed the annual dose limits for occupational workers and general public.

An enclosed radiography installation shall provide for a control room from where the operation of the radiography equipment within the shielded enclosure shall be controlled remotely.

The conduit/opening for cables provided in the wall between the control room and exposure room shall be so designed as to prevent direct streaming of radiation.

In enclosed radiography installations where X-ray equipment or accelerator is operated, the door between the control room and the exposure room shall be provided with an electrical interlock so

as to prevent operation of X-ray equipment or accelerator when the door is open or improperly closed. The interlock shall activate an audio and visual alarm and a placard to caution persons during exposure.

The concentration of ozone in an accelerator installation shall not exceed 0.1ppm at the time of entry in the exposure room. The radiation symbol specified in the Rules shall be conspicuously posted at the entrance. A placard indicating 'RADIATION: RESTRI-CTED ENTRY'(AERB,2019)

2.2.3 Industrial gamma Radiography exposure device (IGRED)

The industrial gamma radiography exposure devices shall be capable of remote operation and control and shall be designed and built to comply with the AERB Safety Standard titled 'Industrial Gamma Radiography Exposure Devices and Source Changers', [AERB/RF-IR/SS-1 (Rev.1)] or equivalent international standard. Only an industrial gamma radiography exposure device or a source changer in respect of which approval of design has been duly accorded by the Competent Authority, shall be marketed, sold, transferred, procured and used, with prior approval of the Competent (AERB,2019).

Source housing

The IGRED is classified as portable, mobile or fixed, depending on its overall weight. Shielding provided by the source housing shall be such that when the control mechanism is securely locked in its 'OFF' condition and a radiography source of maximum rated activity is in the housing, the leakage radiation outside the housing shall not exceed the levels given in the table below.

Table 2.1: Limits on Leakage Radiation Levels

Class of IGRED	On the external	At 5cm from	At 100cm from

	Surface of Source Housing (mSv/h)	External Surface of Source Housing (mSv/h)	External Surface of Source Housing (mSv/h)
Portable	2	0.5	0.02
Mobile	2	1.0	0.05
Fixed	2	1.0	0.10

In order to establish compliance, the radiation level at 5 cm from the surface of the IGRED shall be measured over an area of 10 cm with no linear dimension greater than 5 cm. At 1 m, the area of measurement shall be not more than 100 cm with no linear dimension greater than 20 cm.

The IGRED shall have tamper-proof lock for physical security of the source to prevent unauthorised operation. It shall not be possible to operate the lock unless the source or source assembly is in the fully shielded position (AERB, 2019).

2.3 EMPIRICAL REVIEW

Banerjee (2015) in his study of radiation protection and personnel safety. As highlighted in his studies, ionizing radiation whether from electromagnetic sources like gamma rays or particle sources such as alpha and beta radiation poses significant risks to human health. The detrimental effects of radiation can be deterministic or stochastic, leading to both immediate and delayed somatic effects, which underscores the necessity for comprehensive education in radiation protection. International bodies like the International Commission on Radiological Protection (ICRP) provide vital guidelines that influence national laws on radiation safety. These regulations, which include permissible cumulative doses for occupational exposure, are essential for radiography students to understand as they prepare to enter the workforce. As noted in the

literature, adherence to these standards is critical in mitigating risks associated with radiation exposure, especially in industrial settings where the use of radioisotopes is becoming more prevalent due to initiatives such as India's "Make in India" policy. Furthermore, practical knowledge about radiation measurement instruments including dosimeters and scintillation detectors is integral to the curriculum for radiography students. Understanding the principles of radiation hazard control through distance, time, and shielding can significantly reduce the likelihood of harmful exposure. This awareness not only fosters safer practices among future professionals but also equips them to advocate for effective safety measures within their workplaces.

Ibrahim et al,,.2015 in their study noted that knowledge and awareness of radiography profession among senior science secondary schools students in Bauchi metropolis North-eastern Nigeria Aim: The aim of the study is to assess the level of knowledge and awareness of radiography profession among senior science secondary school students in Bauchi metropolis Northeastern Nigeria. A self-structured questionnaire was administered to 191 students from four secondary schools. Results showed that 62.8% of students were unfamiliar with radiography 70.7% had no knowledge about radiography 84.8% knew about X-rays 95.3% agreed career education is important 59.7% agreed parental guidance influences career choices. This study provides a foundational understanding of the challenges related to awareness in the field of radiography, highlighting a need for improved career guidance, which is relevant to assessing the awareness among radiography students at the University of Benin. Understanding these dynamics can help inform strategies to enhance knowledge and interest in the radiography profession at all educational levels.

Yildiz, & Pekey, (2019) In their study, assessed the knowledge and behaviors of 65 industrial radiography workers regarding radiation protection. The study utilized an online survey and reported a high reliability of the questionnaire, with a Cronbach's alpha coefficient of 0.85. The demographic data indicated that the majority of participants were male, with a significant portion holding a high school diploma and having over 11 years of experience in the field. Findings revealed that most participants demonstrated a strong understanding of fundamental radiation safety concepts, such as the three basic principles of radiation protection (95.4%) and the appropriate use of dosimeters (90.8%). Notably, 100% of the respondents confirmed that they check radiography devices before commencing work, and 98.4% reported using radiation warning signs to restrict access during radiographic tests. However, the study also highlighted gaps in the use of personal protective equipment (PPE), with only 57% of participants consistently utilizing appropriate PPE during their work. Approximately 40% admitted to not using PPE, and 3% were unaware of its importance. This study underscores the necessity for enhanced training in radiation safety and PPE usage among radiography professionals, suggesting a potential area of focus for educational programs, including those at the University of Benin.

Ferreira (2020) in his study the evolution of radiographic techniques, particularly the shift from Film Radiography (RT-F) to Digital Radiography (RT-D), has significant implications for radiation protection and safety. A critical aspect of this transition is the reduction of radiation exposure for radiographers during inspections. Ewert et al.(2011) highlight that one of the primary advantages of RT-D is its ability to significantly lower radiation doses compared to traditional film applications. This reduction not only enhances the safety of radiographers but also aligns with the increasing emphasis on radiation protection training. Research by D'Ademo

et al. (2017) supports this assertion, noting that Imaging Plates (IP) typically require less radiation dose, consequently shortening exposure times. Furthermore, advancements in digital detector technology enable numerical analysis of radiometric images and facilitate quicker imaging processes. Specifically, the exposure time in RT-D can be up to 50% shorter than in RT-F, significantly decreasing the overall radiation dose required to achieve comparable image quality. Given the context of industrial radiography in Nigeria, understanding these advancements is crucial for radiography students. Assessing their awareness of such technologies and the associated safety measures is vital to prepare them for future practices in the field. This thesis aims to quantify, under defined conditions, the reduction in necessary exposure time and dose required for RT-F and RT-D, thereby providing insights into how well-prepared students are to adopt safer, more efficient technologies in their future careers.

Joseph, & Kim, (2021). Assessment of occupational radiation exposure from industrial radiography practice in Nigeria. This study assessed occupational radiation exposure during industrial radiography operations in Nigeria using VISIPLAN 3D ALARA tool. The researchers simulated radiation exposure from Sentinel 880 source projectors with 90 Ci Ir-192 sources and analyzed occupational dose records of radiation workers from 2012 to 2016. Results showed maximum dose from direct exposure was 9.6 mSv/y, below ICRP's 20 mSv/y limit. The study highlights the importance of radiation protection principles and standard operating procedures in industrial radiography.This study supports the need for radiation protection awareness among radiography students in Nigeria. The findings can inform training programs and initiatives to enhance radiation safety knowledge and practices.

Agbo et. al., (2024) in their study focused on determination of awareness of industrial radiography as a career pathway among radiography students in Nigeria. The study aimed to

determine senior radiography students' awareness, attractors, and detractors of IR as a career.cross-sectional study design was used to survey 402 senior radiography undergraduates in selected Nigerian universities. The results of the findings showed that of 402 respondents from seven universities, 221 (55%) were male and 181 (45%) were female; 207 (52%), 176 (44%), and 5% (19) students were in the 18–22, 23–27, and 28–32 years of age range, respectively. 34% and 66% of the samples were 400 and 500-level students, respectively. Three hundred and seventy students (93%) are aware of IR; 58% heard about IR in the classroom while 71% correctly defined IR. The association between students' affiliation and awareness about IR was strong (r = 0.638 and P = 0.0241). Improved remuneration (73%) was the major attractor to IR while students' desire to practice medical radiography and fear of ionizing radiation were the major detractors of IR. Most students (61%)prefer medical to IR (39% and P = 0.01). The study showed that awareness of IR as a career option was very high among senior radiography students in the surveyed Nigerian universities. While most of the surveyed senior radiography students in Nigeria described chances of getting improved remuneration as the basis for selecting IR as a career, they consider their desire to practice medical radiography as well as their fear of hazards associated with the use of ionizing radiation are major detractors to IR as a career pathway.

CHAPTER THREE

METHODOLOGY

This chapter outlines the research design, procedures, and methods employed in exploring the perception of industrial radiography among radiography students at the University of Benin. The purpose of this chapter is to provide a concise description of the study's methodology to enhance transparency and replicability. The research design, population, sampling plan, data collection instruments, data analysis methods, and ethical concerns are described.

3.1 RESEARCH DESIGN

A descriptive research design was used to assess the awareness of industrial radiography among radiography students at the University of Benin.

3.2 TARGET POPULATION

The target population consisted of students from 100 to 500 level in the Department of Radiography, University of Benin, Edo State, Nigeria.

3.3 SAMPLING TECHNIQUE AND SAMPLE SIZE

3.3.1 Sample Size Determination

The sample size for this study was determined using Taro Yamane's (1967) formula:

$$n = \frac{N}{1 + N(e^2)}$$

Where:

- **n** = sample size

- **N** = population size (613)
- **e** = level of precision (0.05)

Thus,

$$n = \frac{613}{1 + 613(0.05^2)}$$

$$n = \frac{613}{1 + 613(0.0025)}$$

$$n = \frac{613}{1 + 1.53}$$

$$n = \frac{613}{2.53}$$

$$n = 242.3 \sim 242$$

Applying a 10% attrition rate: 242+24=266

Thus, the final sample size was **266** students.

3.3.2 Sampling Technique

A multi- stage sampling technique was used:

- Stage One: Stratified random sampling was used to allocate students across different levels.
- Stage Two**:** Systematic sampling was employed to select participants within each level. Questionnaires were administered sequentially until the required sample size for each level was met.

3.3.3 Allocation of Students by Level

Academic Level	Total Students (N)	Sample Size (n)
100 Level	91	39
200 Level	145	62
300 Level	154	67
400 Level	130	56
500 Level	92	41
Total	**613**	**266**

3.4 INSTRUMENT FOR DATA COLLECTION

A self-structured questionnaire was used as the primary data collection instrument (see in appendix 1). It was designed to align with the study's objectives and contained questions that generated insights into students' awareness of industrial radiography.

3.5 VALIDITY OF THE INSTRUMENT

To ensure validity the following steps were taken:

The questionnaire was reviewed by experts to ensure relevance and accuracy.The questionnaire underwent rigorous evaluation by experts to ensure comprehensive coverage of industrial radiography awareness. And finally, the questionnaire was reviewed and approved by the research supervisor.

3.6 RELIABILITY OF THE INSTRUMENT

A pilot study was conducted by administering the questionnaire to 5% of students from each level. Their feedback helped refine the questionnaire's effectiveness in addressing the research questions.

3.7 METHOD OF DATA COLLECTION

Data was collected through face-to-face administration of the questionnaire by the researcher during school session, January 2025.

3.8 METHOD OF DATA ANALYSIS

Collected data was analyzed using descriptive and inferential statistics with SPSS software. Descriptive Statistics: Frequency distribution, mean, and standard deviation will be used to summarize the data. Inferential Statistics: A chi-square test will be used to determine statistical significance.

3.9 ETHICAL CONSIDERATION

Ethical approval was obtained from the Ethical Review Board of the college of Medical Sciencs, University of Benin before conducting the study (see Appendix ii). Informed consent was sought from all participants, ensuring they understood the study's purpose and their right to withdraw at any time without repercussions.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results from the data collected through the questionnaire survey on the awareness of industrial radiography among radiography students at the University of Benin. The data was systematically analyzed and interpreted to provide insights into the research objectives.

The chapter begins with an assessment of the response rate, followed by an analysis of the demographic characteristics of respondents. The awareness levels of industrial radiography among students were examined, along with the factors influencing their awareness. Additionally, sources of information on industrial radiography were identified and discussed.

Furthermore, statistical tests were conducted to determine significant relationships between key variables. Finally, the results were discussed with existing literature, providing a comprehensive understanding of the subject matter.

This analysis helped to evaluate the level of awareness among radiography students and highlight areas that may require improvement in education and training related to industrial radiography.

4.1 Demographic Characteristics of Respondents

This section presents the demographic distribution of the respondents, including gender, age, and level of study.

4.1.1 Gender Distribution

Table 4.1: Gender distribution of respondents

Gender	Frequency	Percentage
Female	143	54%
Male	123	46%

Fig 4.1: Table showing Gender distribution of respondents

The study included a total of 266 respondents. Among them, 143 (53.8%) were female, while 123 (46.2%) were male. This indicates a nearly balanced gender representation among the participants.

4.1.2 Age Distribution

Table 4.2: Age distribution of respondents

Age (yrs)	Frequency	Percentage
18-24	221	83%
25-30	42	15.8%
31-36	3	1.1%

The majority of respondents (221, 83.1%) fell within the 18-24 years age group. A smaller proportion (42, 15.8%) were aged 25-30 years, while only 3 respondents (1.1%) were within the 31-36 years age range. The average age of respondents was 22.2 years, with a standard deviation of 2.1 years.

4.1.3 Academic Level Distribution

Respondents were drawn from all levels of study within the Department of Radiography at the University of Benin. The distribution was as follows:

Table 4.3: Academic level of respondents

Level of study	Frequency	Percentage
100lvl	39	14.7%
200lvl	62	23.3%
300lvl	68	25.6%
400lvl	57	21.4%
500lvl	40	15.0%

The representation across all levels ensured a comprehensive understanding of awareness levels regarding industrial radiography among students at different stages of their academic journey. The average level of study was 300L, with a standard deviation of 1.4.

4.2 Awareness of Industrial Radiography

The level of awareness of industrial radiography among radiography students at the University of Benin was assessed through several key indicators, including general awareness, recognition of industrial radiography as a career path, and sources of awareness.

4.2.1 General Awareness of Industrial Radiography

Table 4.3.1: Awareness of Industrial Radiography among Respondents

Are you aware of industrial radiography?	Frequency	Percentage
maybe	8	3%
yes	185	70%
no	73	27%

The survey revealed that a majority of respondents (69.8%) were aware of industrial radiography, while 27.2% indicated that they were not aware of the field. A smaller percentage (3.0%) were uncertain about their awareness. This suggests that while industrial radiography is recognized among students, there remains a substantial portion of the population that lacks familiarity with the field.

4.2.2 Awareness of Industrial Radiography as a Career Path in Nigeria

Table 4.2.2: Awareness of Industrial Radiography as a career path among Respondents

Aware of industrial radiography as a career	Frequency	Percentage
No	131	49%
Yes	134	51%
Currently industrial radiography is not a popular career		
Yes	237	89%
No	29	11%
Industrial radiography is adequately covered in our curriculum and IR is being taught in my own university		
Yes	53	20%

No	213	80%
The few industrial Radiographers in Nigeria that I know are as popular and a well remunerated as medical Radiographers		
Yes	90	34%
No	176	66%
I perceive Industrial radiography as prestigious career.		
Yes	219	82%
No	47	18%

4.2.3 Sources of Awareness

The study also examined the sources through which students became aware of industrial radiography.

Table 4.2.3: Source of awareness about Industrial Radiography among Respondents

If yes, through what?	Frequency	Percentage
Friends	38	11.4%
Lecture	76	32.4%
Library	25	4.9%
Media	87	38.4%
Others	30	13%

The most commonly cited source of awareness was media, which was mentioned 71 times by respondents. Lectures were the second most significant source, accounting for 60 mentions. Other sources included discussions with friends (21 mentions), library resources (9 mentions), and miscellaneous sources (35 mentions). These results highlight the role of educational resources and informal communication in disseminating knowledge about industrial radiography.

This is consistent with Agbo et al. (2024), who found that 58% of respondents learned about industrial radiography in the classroom. However, the reliance on media suggests an increasing role of digital platforms in knowledge dissemination.

Overall, while there is a moderate level of awareness among radiography students at the University of Benin, the data suggests the need for more targeted educational efforts to enhance understanding of industrial radiography, particularly as a career path in Nigeria.

4.3 Factors Influencing Interest in Industrial Radiography

Students cited various reasons for considering or disregarding industrial radiography as a career option. Tables 4.4.1 and 4.4.2 summarizes key motivating and discouraging factors.

Table 4.3.1: Attractors to Industrial Radiography

Attractors to IR as a career choice	Frequency	Percentage
To satisfy personal curiosity	40	15%
Opportunity to work in an industry instead of a hospital	78	29.3%
Interest to undertake nonmedical research Radiography	42	15.8%
improved remuneration	78	29.3%
The issue of radiation safety could be better handled in IR	28	10.5%

Improved remuneration and opportunities to work outside hospitals (both 29.3%) were key attractors.

Table 4.3.2: Detractors to Industrial Radiography

Detractors to IR as a career choice?	Frequency	Percentage
Interest to practice medical Radiography	80	30.1%
Fear of radiation hazard	68	25 .6%
Poor understanding of the nature of IR	73	27.4%
Lack of mentors to look up to	32	12%
Fear of being perceived as being poorly educated/trained people	13	4.9%

Medical radiography preference (30.1%) and fear of radiation exposure (25.6%) were major deterrents.

4.4 Recommended Strategies for Improving Awareness

Respondents provided recommendations on how to improve awareness and interest in industrial radiography. The most suggested strategies are outlined in Table 4.4.3

Table 4.4.3: Recommended Strategies for Improving Awareness

Strategy	Frequency	Percentage (%)
Workshops and seminars on industrial radiography	174	32.1
Guest lectures from professionals in the industry	109	20.1
More practical training and exposure	140	25.8
More curriculum focus on industrial radiography	80	14.8
Internship programs in relevant industries	39	7.2
Do you think universities like the University of Benin should collaborate with industries to improve students' knowledge and exposure to industrial radiography?		
Yes	237	89
No	10	3.8
Not sure	19	7.1

Workshops (64.6%) and practical training (52.1%) were the most favored strategies for increasing awareness.

Table 4.4.4: Cross-tabulation of Level of Study and Awareness of Industrial Radiography:

Level of Study	Aware (Yes)	Not Aware (No)	Total
100L	12	27	39
200L	29	33	62
300L	41	26	67
400L	27	30	57
500L	26	15	41
Total	135	131	266

Table 4.4.5 Chi-Square Test Showing Relationship Between Level of Study and Awareness of Industrial Radiography

Test	Value	df	Sig. (2-sid
Pearson Chi-Square	13.20	8	0.10
Likelihood Ratio	13.25	8	0.10

Both the Pearson Chi-Square and Likelihood Ratio tests indicate that there is no significant relationship between level of Study and Awareness of Industrial Radiography at the 0.05 significance level. This means we fail to reject the null hypothesis and conclude that the observed differences in awareness levels across different levels of study are likely due to random chance.

4.6 Discussion of Results

69.5% of respondents are aware of industrial radiography, while 50.4% are aware of industrial radiography as a career. Ibrahim et al. (2015) highlighted that 62.8% of secondary school students were unfamiliar with radiography, indicating a gap in awareness at earlier educational levels. He also noted that parental guidance and career education significantly influence career choices, which may explain why industrial radiography is not perceived as a popular career despite its prestige.

Media (38.4%) and lectures (32.4%) are the primary sources of information. Ferreira (2020) discussed the role of digital technologies in improving awareness and safety in radiography,

79.7% of respondents feel that industrial radiography is not adequately covered in their curriculum. Workshops and seminars (65.4%) and practical training (52.6%) are the most recommended methods for improving awareness. Banerjee (2015) emphasized the importance of comprehensive education in radiation protection, which aligns with the finding that 79.7% of respondents feel industrial radiography is not adequately covered in their curriculum.

The primary attractors are the opportunity to work in an industry (29.3%) and improved remuneration (29.3%). While the main detractors are the preference for medical radiography (30.1%) and fear of radiation hazards (25.6%). Razak et al., (2023) emphasized the importance of safety measures, such as shielded enclosures and monitoring. Ferreira (2020) and Joseph & Kim (2021) stress the importance of modernizing radiographic training to enhance radiation protection and operational efficiency

The results indicate that while there is some level of awareness about industrial radiography, a significant proportion of students lack adequate knowledge about the field. The chi-square tests conducted in this study revealed a significant relationship between age group and awareness ($p = 0.004$) and between awareness of industrial radiography as a career and general awareness ($p < 0.001$). However, no significant relationships were found between gender, level of study, curriculum coverage, or perception of prestige and awareness levels. These results suggest that while certain factors like age and career awareness play a role in shaping students' perceptions, other factors such as curriculum coverage and gender do not significantly influence awareness levels.

Respondents provided several recommendations to improve awareness and adoption of industrial radiography, including:

- Providing incentives or funding for companies investing in modern radiography solutions.
- Transparent information about competitive salaries, benefits, and career growth opportunities.
- Educational campaigns by the radiography department to teach students about industrial radiography.
- Serious awareness campaigns to highlight the benefits of industrial radiography.
- Seminars, TV programs, and inaugural lectures to promote industrial radiography.
- Setting up appropriate equipment and quality assurance programs to ensure safety and encourage career adoption.

By implementing the recommendations provided by respondents, stakeholders can foster greater interest and participation in industrial radiography, ultimately contributing to the development of a skilled workforce and the safety of Nigeria's industrial infrastructure.

CHAPTER FIVE:

CONCLUSION AND RECOMMENDATIONS

5.1 Recommendations

Based on the study findings, the following recommendations are proposed:

- Industrial radiography should be added as a specialized course or an elective in the curriculum of radiography with considerable emphasis placed on practical training and radiation safety protocols.
- Universities must formulate alliances with industry to perform internships of the students, technical workshops, studies, and expert guest lectures in the profession.
- Special awareness programs, including media awareness programs, seminars, and workshops, must be instituted to expose students more to industrial radiography as a potential career option.

5.2 Limitations of the Study

The study has the following limitations:

- The study was limited to a specific group of radiography students, which may not be representative of all radiography students in Nigeria.
- The study was conducted in a specific region, and the findings may not be generalizable to other regions.
- The data was self-reported, which may introduce bias and inaccuracies.
- The study used a cross-sectional design, which limits the ability to establish causal relationships.

5.3 Suggestions for Further Research

To address the limitations of this study and build on its findings, the following areas are suggested for further research:

1. Conduct longitudinal studies in order to track awareness and industrial radiography perception shifts over time.
2. Expand the study population to include radiography students from different regions of Nigeria in order to increase generalizability.
3. Use qualitative methods, such as interviews and focus groups, to gain a deeper understanding of students' experiences and perceptions.
4. Compare the perception and awareness of students in different countries concerning industrial radiography in order to establish best practices.
5. : Assess the influence of curriculum revision, awareness drives, and industrial associations on the awareness and career orientation of students.

5.4 Conclusion

This study investigated awareness of industrial radiography among students of radiography in the University of Benin in Nigeria. Findings revealed that awareness of industrial radiography is quite good, although there are some lacunae in practice and curriculum coverage. The interest in medical radiography and fear of radiation hazards are major negatives, and there is a need for appropriate career guidance and radiation safety education. The study emphasizes the inclusion of industrial radiography in the curriculum, the promotion of industry-university partnership, and undertaking awareness programs to promote industrial radiography as a career option. By concentrating on these elements, Nigeria will be in a position to establish a highly trained

manpower in industrial radiography, which will promote the safety and integrity of its industrial structures.

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APPENDIX 1

QUESTIONNAIRE

Dear Respondent,

This questionnaire is designed to assess your knowledge and perceptions regarding industrial radiography as part of a research project on its awareness among radiography students at the University of Benin. Your responses will be treated with the utmost confidentiality and will be used solely for academic purposes.

Section A: Demographic Information

1. Gender: a)Male b) Female

2. Age: a)18-24 b)25-30 c) 31-35 d)36 and above

3. Level of Study: a)100 level b)200 level c) 300 level d)400 level e) 500 level

Section B: Knowledge of Industrial Radiography

4. Are you aware of IR? A) yes B) no

5. If yes, through which means? A) library B) media C) friends D) lecture E) others

6. Are you aware of IR as a career in Nigeria? A) yes B) no

Section C: Perception of industrial radiography as a career

7. Currently IR is not a popular subspecialty in Radiography. A) yes B) no

8. IR is adequately covered in our curriculum and IR is being taught in my own university. A)yes B) no

9. The few industrial Radiographers in Nigeria that I know are as popular and a well remunerated as medical Radiographers. A) yes B) no

10. I perceive IR as prestigious career. A) yes B) no

11.Attractors to IR as a career choice ? A) Improved remuneration. B) Opportunity to work in an industry instead of a hospital C) To satisfy personal curiosity. D) Interest to undertake nonmedical research Radiography E) The issue of radiation safety could be better handled in IR

12. Detractors to IR as a career choice?

A) Interest to practice medical Radiography B) Poor understanding of the nature of IR. C) Fear of radiation hazard. D) Lack of mentors to look up to E) Fear of being perceived as being poorly educated/trained people

SECTION D: GENERAL OPINION AND RECOMMENDATIONS

13. In your opinion, how can awareness of industrial radiography be improved among radiography students?(Select all that apply) [ ] More practical training and exposure [ ] Guest lectures from professionals in the industry [ ] Workshops and seminars on industrial radiography [ ] More curriculum focus on industrial radiography [ ] Internship programs in relevant industries [ ] Others (please specify) _____

14. Do you think universities like the University of Benin should collaborate with industries to improve students' knowledge and exposure to industrial radiography? a)Yes b) No c) Not sure

15. What other comments or suggestions do you have regarding the promotion of industrial radiography as a career path?

_____

_____

Thank you for your time and valuable input.