

**X-RAY ABSORPTION OF SOIL-CEMENT MIXTURE:
AN ALTERNATIVE FOR LEAD**

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ABSTRACT

This study investigated the potential of a soil-cement mixture as a substitute shielding material for X-ray absorption. As concerns about the effects of lead on the environment and human health have increased, it has become needed to find safer and more sustainable alternatives. In this study, particular soil types were combined with cement, and their capacity to attenuate X-rays was assessed. Experimental results showed that the soil-cement combinations provided shielding effectiveness comparable to lead within diagnostic energy ranges. The researchers collected soil samples from La Union, Philippines. Each soil type was mixed with 2:1, 1:2, and 1:3, molded into bricks, and cured for seven days. The samples were then exposed to X-rays at 70kvp, 200mA, and 4mAs using a calibrated diagnostic X-ray machine. The absorption rates were measured using Fluke Model 451B-BYR Radiation Survey Meter placed behind each sample. The results showed that all soil-cement mixtures significantly absorbed X-ray radiation. Among the samples, the sand-cement mixture exhibited the highest absorption, followed by clay and loam. Despite variations in absorption level, statistical analysis showed no significant difference between the shielding performance of soil-cement mixtures and that of lead, particularly in certain mixture ratios with higher compactness. The study concluded that soil-cement mixtures have the potential to serve as environmentally friendly and effective alternatives to lead. Future researchers should explore variations in mixes, energy-specific shielding effectiveness, and environmental impacts as substitutes for lead. Tests should also be repeated under controlled conditions or with cooled x-ray equipment.

Keywords: *clay, loam, sand, shielding effectiveness, soil-cement mixture, x-ray absorption*

CHAPTER I

The Problem

Background of Study

Radiation is everywhere, and it benefits everyone, from the televisions and radios that people use as a form of entertainment to the UV rays of the sun that are beneficial to plants and humans. While these are a form of radiation, they are not as strong as X-rays, which can ionize the tiniest atom in a human body. This type of radiation is being used for diagnosis to view the internal structures within the body, and treatment of cancer due to its therapeutic abilities to kill cancer cells.

Within a few months of discovery, X-rays were being used worldwide for diagnosis and within a year or two for therapy. It became clear very quickly that while there were immense benefits, there were significant associated hazards for both patients and operators of the equipment. There was a warning against the cumulative effects of repeated irradiation, together with instructions for providing lead or other such shielding around the X-ray source. Heinrich Albers-Schönberg (himself an early victim of chronic X-ray dermatitis) suggested a leaded tube housing, and additional lead shielding for the operator. In the modern era, the protection of staff and patients improved with the use of personal protective equipment (e.g. lead aprons and thyroid collar shields), developments in the accuracy and quality of radiation instrumentation, radiation dosimetry, and improvements in imaging and equipment design and operation (Boice, et.al., 2020).

Using or inserting the proper shield between an exposed person and a radiation source can greatly reduce or eliminate the dose received. Shielding measures minimize the radiation absorbed by anyone who may be exposed to sources of radiation. The importance of shielding in radiation is based on the principle of attenuation. Attenuation is the degree to which a radio wave

or ray's effect can be blocked or bounced with the use of a barrier material. The barrier's use depends on the type of radiation it is trying to block. For penetrating radiation (think gamma rays and neutrons), lead, concrete, and water provide the best level of protection. This is the reason that dentists place a lead blanket on a patient when X-rays of the teeth are being taken. It is also why certain radioactive materials are stored underwater or in concrete or lead-lined rooms. When it comes to alpha radiation and beta radiation, special plastic shields can stop beta particles, and air stops alpha particles. The amount of shielding required depends on the intensity of the penetrating dose. Metals are often used due to their strength and high resistance to radiation damage. Lead's higher atomic number enables it to lessen the effects of gamma and x-rays. Generally, the higher the density of a material, the more effective it will be at blocking gamma and x-ray radiation. However, it is possible that lower-density materials can become more effective with increased thickness (Perkins, 2024).

Recent research highlights several materials suitable for radiation shielding. Heavy aggregates such as barite and magnetite have been tested in concrete mixes, showing strong potential for blocking gamma rays and X-rays due to their high density and atomic makeup. These materials offer innovative possibilities for use in hospitals, medical facilities, and nuclear sites, including the integration of locally available resources like soil-cement composites (Abdullah et al., 2022). Studies on ultra-high-performance concrete mixed with heavy minerals like ilmenite have shown even better shielding performance, encouraging further exploration of diverse materials for protective applications (Zhou et al., 2023).

The structural planning of an exposure room is commonly lead-lined. One of the radiation regulatory governing bodies, the Food and Drug Administration (FDA) stated that the standardized wall as mentioned in the general radiography requirements should have adequate shielding for the x-ray room (doors, walls, etc.) of at least 6 inches thick poured concrete with a

density of 2.35 g/cm^3 and at least $1/6$ in (1.5 mm) thick lead sheet glued onto and sandwich between wooden panels without any punctures during installation (FDA, 2020).

According to the results of the study of Haydon (2022), to find out the exact lead shielding required for the X-ray room, a medical physicist known as a Radiation Protection Adviser (RPA) will be required to calculate the requirements and to ensure radiation exposure is kept to a minimum. X-ray rooms are placed in the lowest part of a building to reduce the possibility of radiation traveling through the floor. If there is no choice but to locate the X-ray room on an upper level of the building, lead lining to the floor area is required. The control area must remain protected with lead-lined screens, windows, walls, and doors. X-ray room doors should be lead-lined with BS EN 12588 standards. The higher the dosage of radiation the thicker the lead. The level of shielding required in the walls is determined by an RPA and will differ depending upon the usage of the room. The shielding glass is made from radiation glass solution with 1.8mm to 3.5mm thickness.

Throughout the examination of the structural shielding of a radio diagnostic center in Jos, Nigeria due to the high workload related to the population increase, a thickness of lead, gypsum, concrete, wood, and steel plate was determining the possible choice of wall reinforcement. The 0.5 mm equivalent lead thickness was the perfect fit for the shielding reinforcement due to the cost, problem, and unavailability of other materials that give reliance on that economic aspect, there is no commercial product that has excellent shielding ability and workability of lead (Yusuf et al., 2020).

Lead shielding refers to the use of lead or lead-based materials as a protective barrier to absorb or block ionizing radiation, particularly X-rays and gamma rays. Due to its high atomic number and density, lead is highly effective at attenuating radiation, making it a common material for personal protective equipment (e.g., lead aprons and thyroid shields), structural shielding in

radiology rooms, and mobile barriers in medical and industrial settings. (Bushong S. C.,2021). A 2023 study confirmed that 0.5 mm lead-equivalent aprons offer superior protection, especially above 90 kVp, compared to lead-composite and lead-free types (European Journal of Radiology, 2023). Another trial showed that 0.6 mm aprons reduced radiation by over 90%, while 0.3 mm aprons achieved around 78%, highlighting the effectiveness of thicker aprons (Medicine, 2023). However, the use of metallic lead introduces significant health and environmental risks, as lead particles can transfer to hands, clothing, and accumulate on laboratory surfaces (UC San Diego, 2024). Lead, a naturally occurring toxic metal, has caused extensive environmental contamination and public health issues globally. Even at lower exposure levels, which often lack symptoms, lead can cause widespread damage to various body systems (World Health Organization, 2024).

Lead has traditionally been preferred for various applications in radiation shielding because of its quality. However, lead is highly toxic to human health and poses real risks to the whole environment. This study looks at the development and application of acceptable environmental alternatives to lead in x-ray shielding. Besides this, mining, processing, and waste from lead may result in serious problems for the environment. It can contaminate water, soil, and air; in this way, lead has a very strong impact on the environment in the long term (Raj & Das, 2023).

The widespread use of lead in radiation protection has driven the need for safer, more sustainable alternatives due to its health and environmental challenges. Soil has emerged as a promising substitute, offering affordability, accessibility, and environmental benefits. This research explores the potential of specific soil types to serve as cost-efficient alternatives to lead for X-ray radiation shielding. Soil, composed of particles such as sand, loam, and clay, forms aggregates with distinct mineral compositions that may act as effective radiation shields. Studies indicate that the soil's physical properties make it suitable for evaluation as a greener shielding

material. For instance, sand is commonly used in construction, while loam is valued for its nutrient-rich composition, and clay is widely utilized in architectural designs and industrial processes (Almusaed et al., 2023).

Recent investigations have emphasized soil's potential to reduce X-ray radiation, highlighting its viability as a substitute material. By examining the attenuation capabilities of soil, this study aims to provide a safer and cost-effective solution, reducing reliance on lead while maintaining effective radiation protection. The latest studies by Hila et al. (2021) introduced complete explorations of the effectiveness of the soil samples from the Philippine Island as a radiation shielding material. Those authors focused on the significance of the silicon dioxide (SiO_2) absorptions in soils to attenuate radiation and reported that an increase in the aggregate of silica developed in a negative connection with the effective atomic number.

According to the study of Schimze Sagon and Petal Padmini Surujpaul in 2020, "The Use of Local Alternative Materials as Structural Shielding for Diagnostic Radiological Facilities" Blocks composed of white sand and clay soil with cement mixture, can be used as structural shielding. White sand attained the highest density and compressive strength, however, cement and clay soil proved to be most stable, both in its engineering properties and attenuating ability.

The study of Gili and Hila in 2021 entitled, "Investigation of Gamma-ray Shielding Features of Several Clay Materials Using the EPICS2017 Library" proved that ball clay and kaolin clay demonstrated desirable radiation shielding characteristics. In the local province of La Union, there has not been any study about the radiation reduction ability of soil.

Alternatives to lead shields are urgently required. The researchers are able to come up with the study entitled, "X-Ray Absorption of Soil: An Alternative for Lead" This study focused on operative material for X-ray shielding but without any hazards to human life or ecological threat.

The objectives were to achieve the specified certain attainment concerning the

effectiveness of different types of soil, including loam, clay, and sand, in X-ray radiation attenuation. The first objective of this research was to establish how different degrees of compactness have a bearing on the capabilities of various soil materials to absorb X-ray radiation effectively. Therefore, an analysis through such research on the relations of soil density with the absorption of radiation established the optimal degree of compactness required for effective shielding. In this study, density played a major part because it determined how dense or how porous that soil is and eventually determined the ability of the soil to absorb or block X-rays. This may help explain if the soil is a potentially viable, sustainable, and cheap alternative to lead to radiation shielding.

The capability of how different ratios thickness of soils can be an attenuation factor was also investigated through this research on these soil materials, hence, useful to understand the selection of an appropriate shielding method. The objectives to identified which type of soil has the highest percentage of effectiveness in terms of the absorption of X-ray radiation penetration. The research compared loam, clay, and sandy soils to find the most suitable one in all soil types for the shielding of radiation protection.

Finally, the research work determined the most effective type of soil for practical applications such as radiation shielding material from either health or industry perspectives. Optimal type and condition identification in this research work will add to the development contribution for effective sustainable radiation shielding.

Soil differs in its type, color, composure, and physical properties. There are many types of soils we have, including clay, loam, and sand, each with specific uses. As for clay, we use it for pottery making, for medicinal purposes as clay minerals for bacterial agents, we also use clay for construction, and many more. But according to Almusaed et.al. (2023), clay minerals are used in various processes of architectural designs, industry engineering, recovery, and refining, which are

the things that apply to their structure and composition. We also use sand for the construction of buildings and for concrete materials such as iron. Loam is also good for plant cultivation and its capacity to have rich nutrients.

Soil is composed of chemical composition and physical properties. Soil has resulted in increased organic carbon soil. These elements help the soil to handle shielding and penetration. When a gamma-ray beam passes through a soil sample of thickness x (cm), the photons are transmitted according to Beer-Lambert's law. This proves that soil can attenuate radiation. Lead can also be found in soil, and it is because of the contamination of heavy metals in soil (Jakab et al., 2023).

Soil is quite effective in stopping alpha and beta particles due to its composition. Soil and clay are naturally available, cheap, and environmentally friendly and can be efficient in permeability and radiation disposal and attenuation. While gamma rays are more penetrating, they need more dense and compact materials to be attenuated. Soil has a complex and diverse composition of different minerals, gases, and metals, including water. According to Singla and Dhingra (2024), clay loam and sandy loam soils have much higher attenuation coefficients. Their study also found that the attenuating ability of a matter, specifically soil, depends on radiation and the composition of the soil itself.

In neutrons, soil can also attenuate radiation, but it depends on the composition of the soil. According to Singla and Dhingra (2022), soils that have higher moisture content and soil bulk density are good at attenuation because of the presence of hydrogen atoms. This means that clays and loams can also have a higher chance of attenuating radiation. Soil has the power to attenuate radiation, especially the alpha and beta particles, even if it has only a thin layer. Soil can attenuate radiation, but it depends on the penetrating intensity of the radiation. However, if the soil has a more compact and denser structure, it may attenuate the radiation because of its density and

thickness.

The identification of soils from various ecological and geographical entities, such as ecosystems and landscapes, are very critical. The nature of soil health and ecosystem services needs to be underpinned with reliable field data through measurable indicators of soil performance and degradation. Furthermore, participatory approaches that involve stakeholders are essential in managing competing interests and ensuring the long-term sustainable use of soils. Therefore, knowledge of the type of particle and size distribution in soil influences the behavior of the incoming radiation may help us understand whether it will be effective for radiation shielding (Saljnikov et al., 2022).

Previous works illustrated how properties of the soil, like density or porosity, may affect radiation transmission and absorption. In contrast, there is very limited work done concerning how different particle sizes of soil are affecting its radiation shielding capability. In this work, three important parameters, namely mass attenuation coefficient, effective atomic number, and electron density, will characterize the radiation shielding efficiency of the material.

In some studies, utilizing the X-ray methods of studying the chemical composition of the soil, the researchers strive to find out whether the particle size would affect the shielding efficiency of the soil. More recently, due to its abundance and effectiveness, soil has come to attention as a potential alternative material for radiation shielding. Soil is widely available across different landscapes and presents a low-cost alternative to traditional shielding materials like lead. The natural composition of minerals and organic matter within the soil provides good properties of radiation absorption. Whereas parameters like grain size and pressure have been observed to affect the attenuation efficiency of soil for gamma radiation, in general, it is a feasible substitute for radiation protection.

According to UltraTech Cement (2021), considering the various types of soil is one of the

most important design options. Understanding the different types of soil and its qualities is essential when establishing the foundation for a project. Loam is one of the best types of soil for construction. It has the ideal proportions of sand, silt, and clay. This allows the foundation to be strong. Loam does not shrink, expand, or shift when exposed to water. Sand and gravel contain large particles, allowing water to drain fast (which is good for buildings). Retaining less water reduces the likelihood of the building shifting and forming structural and non-structural faults. Compacted sand and gravel provide even more solidity and are an excellent option for building.

Furthermore, structures made out of clay bricks that was built hundreds of years ago in the Philippines are still standing strong in the 20th century. As stated by Cayme, J. C. et al. (2021) Brick masonry is one of the primary construction materials together with stone masonry that was extensively utilized since antiquity until the present times. In the context of the Southeast Asian region, this masonry type is a material of choice for building ancient temples, fortifications and other colonial period structures.

According to the General Guidelines with Regards to The Design of X-Ray Rooms as stated by the South African Health Products Regulatory Authority (2022), a 230 mm kiln baked solid clay brick may be used as in the walls of the radiographic room. Furthermore, clay also has good refractory properties (high melting point, which can produce resistance to fire, poor conductor, resistance to thermal shock, etc.). In this study, given the general distribution of these soils and their distinctive composition at a greater distance, investigation into their attenuation effects is needed. Also, understanding how weathering affects soil mineralogy and its relationship with radiation is crucial for improving the use of these soils in radiation requisitions.

Soils enriched with heavy oxides like Ferric Oxide (Fe_2O_3) have shown strong potential as accessible and effective radiation shielding materials due to their composition. Similarly, concrete is commonly used for radiation protection because of its structural properties and the role of

aggregates and binders. A 2021 study found that incorporating basalt-magnetite aggregates into concrete increased its linear attenuation coefficients, enhancing its gamma radiation shielding capability. This highlights the importance of selecting suitable aggregate materials to improve concrete's shielding performance (Gunoglu & Akkurt, 2021).

The consideration of using a soil-based material in radiation protection will have great implications for industries that rely on lead for shielding. For instance, in the health sector, applications of soil in the construction of X-ray rooms and diagnostic laboratories will not pose any toxicity risk. In industrial processes related to the use or production of radiation, the use of an effective soil-based shield can decrease occupational hazards of radiation exposure while minimizing environmental damage. This would, at best, open avenues toward the preparation of mixtures of soils with optimized radiation attenuation with minimal environmental impact. Shielding materials based on soils would surely revolutionize the landscape in radiation protection if their efficacy were proven, offering safer and more sustainable alternatives compared to lead. Soil, being a natural and abundant material, seems to give an affirmative answer. These materials are abundant in various quantities across the study area. Hence, it always remains vital to develop new and improved materials that can serve under probable severe conditions of radiation exposure and act as shield materials for extended lengths of time. This includes the use of soil for radiation protection; given the reasons for its cheapness and ecological cleanness, it should be an ideal candidate to be further investigated (Gili et al., 2021).

This study offers significant benefits to various stakeholders. It supports the International Commission on Radiological Protection by presenting an effective, non-toxic, soil-based alternative to lead for X-ray radiation shielding, promoting safety, accessibility, and sustainability in radiation protection. Nationally, it encourages eco-friendly methods that reduce reliance on harmful materials, fosters local industry growth, and utilizes abundant resources from La Union

Province, potentially creating jobs and boosting the local economy. For society, it enhances healthcare affordability and safety by replacing toxic lead with a sustainable alternative, protecting people and the environment while advancing public health. Radiologists and radiologic technologists will benefit from safer and less expensive radiation protection, improving conditions for both medical staff and patients in hospitals and clinics. Patients will also benefit from this innovation, as the use of soil-based shielding materials can reduce their exposure to toxic substances like lead, ensuring a safer environment during diagnostic procedures. This research also boosts Lorma College's reputation for innovation, motivates students and educators to pursue groundbreaking ideas, and encourages collaboration with other institutions. Furthermore, it provides valuable insights for future researchers aiming to develop safer, cost-effective X-ray shielding methods and opens opportunities for recognition and further advancements in the field of radiation protection.

Conceptual Framework

This study is guided by three main concepts. First, the Cardinal Principles of Radiation Protection focus on reducing exposure to radiation especially through proper shielding. Second, the Monte Carlo Simulation helps us predict how X-rays behave when passing through materials. Lastly, the Beer-Lambert Law explains how X-rays are absorbed depending on the material's thickness and type. These principles help us understand and test how effective soil-cement mixtures can be as a safer and cheaper alternative to lead in radiation protection.

The Cardinal Principles of Radiation Protection—time, distance, and shielding—are essential in minimizing radiation exposure and directly relate to this study, which investigates clay, loam, and sand as alternative materials for x-ray radiation shielding. Limiting or minimizing the exposure time reduces the dose from the radiation source. The Principle of Distance emphasizes, just as the heat from a fire reduces as you move further away, the dose of radiation decreases

dramatically as distance from the source is increased (EPA, 2025). Shielding is based on attenuation or the gradual reduction in the intensity of energy through a specific medium. X-ray radiation that passes through certain materials decrease and are absorbed, thereby reducing the exposure to the other side of the barrier (Versant Physics, 2022). This research aims to evaluate the potential of clay, loam, and sand as effective alternatives to lead, considering their ability to shield against x-rays. By applying these principles of radiation protection, this study not only aims to identify cost-effective and environmentally sustainable materials for radiation shielding but also ensures that these materials align with the fundamental guidelines for reducing exposure and protecting individuals in radiation-prone environments.

The Monte Carlo Simulation is a computational method that utilizes random sampling and statistical modeling to solve complex physical and mathematical problems. Originally developed during the Manhattan Project, it has since been widely applied in radiation physics due to its ability to simulate the interaction of radiation with various materials. In the context of this study, the Monte Carlo Simulation is employed to model how x-rays behave when passing through different soil types—specifically clay, loam, and sand. By accounting for key variables such as density, composition, and thickness, the simulation can predict the level of x-ray attenuation each material provides.

This approach enables a detailed analysis of the shielding capabilities of soil-cement mixtures without requiring extensive physical experimentation. It supports the identification of soil configurations that offer optimal radiation protection while remaining cost-effective and environmentally sustainable. Through these simulations, this study can determine which soil mixtures have the potential to serve as viable alternatives to lead, aligning with both economic and ecological goals in radiation protection.

The Beer-Lambert Law (BLL) is a scientific principle that describes the attenuation of

electromagnetic radiation, such as x-rays, as it travels through a medium. The law states that the intensity of radiation decreases exponentially as it passes through a substance, depending on the material's thickness and density, as well as the concentration of absorbing components. In this study, the BLL is applied to evaluate how different types of soil—namely clay, loam, and sand—affect the attenuation of x-rays. This allows for a quantitative analysis of each material's effectiveness in reducing radiation intensity.

By utilizing BLL, researchers can estimate how changes in soil properties influence the material's ability to block or absorb radiation. This is especially important in identifying optimal soil mixtures and thicknesses that can serve as substitutes for lead in radiation shielding. The law's simplicity, accuracy, and computational efficiency make it a practical tool for modeling radiation behavior in various materials. Its application in this study reinforces the potential of soil-based materials as safe, accessible, and sustainable solutions for x-ray shielding, particularly in environments where conventional lead shielding is impractical or hazardous.

The research paradigm follows the cause-and-effect model. The independent variables include the materials used such as the type of soil used (sand, loam, or clay), the mixing ratios of cement to soil by weight in kg (2:1, 1:2, and 1:3), the sample thickness (maintained at 4 inches for all test samples), and the technical exposure factors (set at 70 kVp, 200 mA and 4 mAs). These technical factors are commonly used in chest radiography procedures, where 70 kVp is frequently applied to achieve optimal image contrast while ensuring adequate penetration of the x-ray beam through the chest cavity. This serves as a reference for evaluating the shielding effectiveness of the soil-cement mixtures.

In the process phase, the study involves preparing the soil-cement mixtures by collecting, labeling, drying, and sieving the soil samples before mixing them with cement in the specified ratios. The mixtures are then molded into 4-inch-thick test samples. These samples are subjected

to x-ray exposure using constant technical factors to evaluate their radiation absorption capacity.

The dependent variables focus on determining which soil-cement mixture best absorbs X-ray radiation while maintaining structural integrity. Additionally, the study assesses the ability of these mixtures to absorb radiation, contributing to the evaluation of their potential as alternative radiation shielding materials.

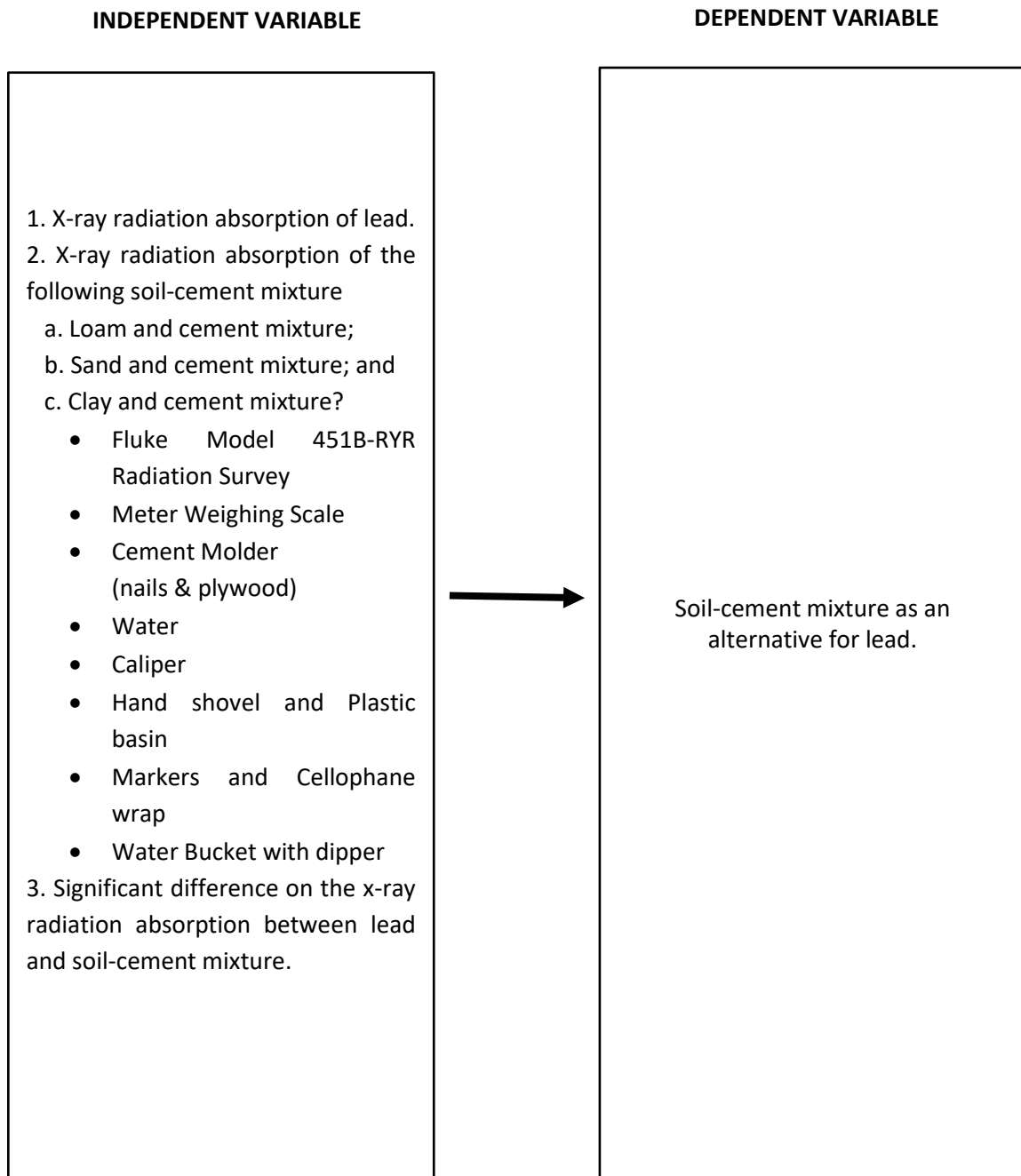


Figure 1: *Causal Paradigm*

Statement of the Problem

The study determined the absorption capacity of soil-cement mixture as an alternative for lead.

Specifically, it answered the following questions:

1. What is the x-ray radiation absorption of lead?
2. What is the x-ray radiation absorption of the following soil-cement mixture?
 - a. Loam and cement mixture;
 - b. Sand and cement mixture; and
 - c. Clay and cement mixture?
3. Is there a significant difference on the x-ray radiation absorption between lead and soil-cement mixture?
4. Based on the experiment, what soil-cement mixture can be an effective alternative for lead?

Hypothesis

There is no significant difference on the X-ray radiation absorption between lead and soil-cement mixture.

CHAPTER II

Methodology

This chapter provided a detailed overview of the research design, locale of the study, data gathering procedures, and methods used for data analysis.

Research Design

This study made use of an experimental design with a controlled, laboratory-based setting. Experimental designs are recommended owing to their ability to permit cause-and-effect relationships among variables in highly controlled situations. This design is particularly well-suited for the testing of materials and engineering research, especially under conditions where precision and reproducibility become critical. Material radiation attenuation property studies more often use experimental designs aimed at optimizing variables such as density, thickness, and composition to improve efficiency in shielding (Sagon and Surujpaul, 2020).

This design produced statistically valid results that allow for innovation in developing effective and sustainable alternatives for shielding against radiation, in tune with global trends in green and efficient construction materials.

Locale of the Study

The experimental research was carried out in the laboratory of the Radiologic Technology Department at Lorma Medical Center in Carlatan, City of San Fernando, La Union. The study further sought to determine through a controlled laboratory experiment how various combinations of cement and soil (loam, sand, and clay) can be used as X-ray shielding materials in comparison to lead. These studies, being highly controlled experiments, provide a significant level of internal validity by allowing for a high level of precision in the manipulation of the independent variables and accurate measurement of the dependent variable. This design allows for easy evaluation of the X-ray shielding effect of the material, lead, which is the standard for X-

ray shielding materials.

Materials and Equipment

The loam was used as one of the main materials for making bricks. It is made up of approximately 54% sand, 28% silt, and 18% clay. The loam soil was mixed with cement and water to make a cement and clay mixture to make the brick. The ratios of the cement and loam mixture were 2:1, 1:2, and 1:3, with a quantity of 3 for each ratio. In addition, the dimensions of each brick were 4 x 6 x 4.

The sand was the second soil type used as one of the main materials for making bricks. It is made up of 86% sand, 6% silt, and 8% clay. The sand was mixed with cement and water to make the cement and sand mixture to make the brick. The ratios of the cement and sand mixture were 2:1, 1:2, and 1:3, with a quantity of 3 for each ratio. In addition, the dimensions of each brick were 4 x 6 x 4.

The clay was the third soil type used as one of the main materials for making the bricks. It is made up of 30% sand, 24% silt, and 46% clay. The clay soil was mixed with cement and water to make the cement and clay mixture to make the brick. The ratios of the cement and clay mixture were 2:1, 1:2, and 1:3, with a quantity of 3 for each ratio. In addition, the dimensions of each brick were 4 x 6 x 4.

The RaySafe ThinX RAD X-ray Meter is a fully automatic X-ray meter designed for radiographic applications. It measures parameters such as kilovolt peak (kVp), dose, dose rate, exposure time, pulses, and half-value layer (HVL). This device ensures accurate measurement of the X-ray beam's characteristics, allowing for precise assessment of how different soil samples attenuate X-ray radiation. Fluke Model 451B-RYR Radiation Survey Meter, a handheld ion chamber survey meter equipped with a sliding beta shield. It measures exposure and dose rates of ionizing radiation, including alpha, beta, gamma, and X-rays. This instrument is essential for

monitoring radiation levels in and around this experimental setup. It ensures safety by detecting any unintended radiation exposure and helps validate the effectiveness of soil samples as shielding materials against various types of ionizing radiation.

To ensure accurate data collection, pen and paper were used to manually record results, minimizing the risk of accidental typos, while a laptop helped create a soft copy and organize the data into a spreadsheet. Rulers or calipers were used to measure the volume and thickness of the soil samples with precision, preventing size variations from affecting the results. A weighing scale provided accurate measurements of the soil and cement mixtures, ensuring consistency in sample preparation. Additionally, a camera documented the experimental setup, capturing detailed visual records of material arrangements, equipment positioning, and environmental factors.

For the molding process, plywood was used to create a smooth surface for the bricks, while wood served as a durable base. Nails fastened the plywood to the wood, ensuring stability and precise brick dimensions. Trowels were used to flatten the edges of the concrete-soil mixture, preventing overflow and maintaining uniformity. A shovel aided in digging, mixing, and transferring large portions of soil, while a basin served as a mixing container for the different soil types and cement.

Data Gathering Tools

In this study, the researchers utilized observation sheets and a checklist as primary data-gathering tools to systematically assess the radiation-shielding properties of different soil samples. The observational approach involved closely monitoring the soil's physical properties, particularly its ability to attenuate X-rays, while recording relevant data such as measurements, weight, and other pertinent characteristics. A weighing scale was employed to determine the precise mass of each soil sample, which is crucial for ensuring consistency across the experiments. Accurate mass measurement is fundamental to this study, as it allowed the researchers to control

the amount of material used and draw valid conclusions about the soil's shielding capabilities. Additionally, by measuring both the mass and the volume of each sample, the researchers calculated the density of the soil, a key factor in evaluating its effectiveness as a radiation shield. Soil density, which reflects its porosity or compactness, is an important indicator of how well the material can absorb or block X-rays. By determining the soil's density, the researchers gained insights into whether the material is a viable, sustainable, and effective alternative to traditional lead for radiation shielding. This analysis is essential to determine the efficiency of the soil in reducing radiation exposure, contributing to the overall understanding of its potential applications in radiation protection.

To manage, organize, and analyze the collected data, the researchers relied on checklists, data recording sheets, and electronic spreadsheets. The checklist served as a tool to ensure that all relevant data points are documented in a consistent and structured manner, preventing any omissions during the data-gathering process. Data recording sheets were used for manual documenting measurements, while the use of electronic spreadsheets provided greater flexibility and efficiency in managing the data. Spreadsheets are particularly useful for performing complex calculations, tracking experimental results over time, and visualizing trends, which helped the researchers interpret the data more effectively. They also offered the advantage of easy updates and modifications, allowing for real-time analysis and identification of any irregularities or patterns that emerge (Rain et al., 2021). Additionally, cameras were employed to document the experimental setup, conditions, and procedures visually, providing supplementary evidence to support the findings. This visual documentation helped ensure transparency and allowed for the verification of the experimental process. By combining observational techniques with structured data organization and digital tools, the researchers ensured that the data collection process was both comprehensive and reliable, enhancing the credibility and trustworthiness of the study's

conclusions regarding the soil's potential as a radiation-shielding material.

Soil samples were selected based on density and composition characteristics relevant for optimum shielding. This ensured that focused testing is done on materials that have the potential for high attenuation efficiency. Systematic preparation of mix ratios of soil and cement was done in 2:1, 1:2, and 1:3, compacted into samples of 4-inch thickness and subjected to controlled radiation testing. Advantages of such experimental setups include that they give more reliable results, further to sustaining natural resources by seeing the local availability of materials for critical radiation protection applications (Dovetail Editorial Team, 2023).

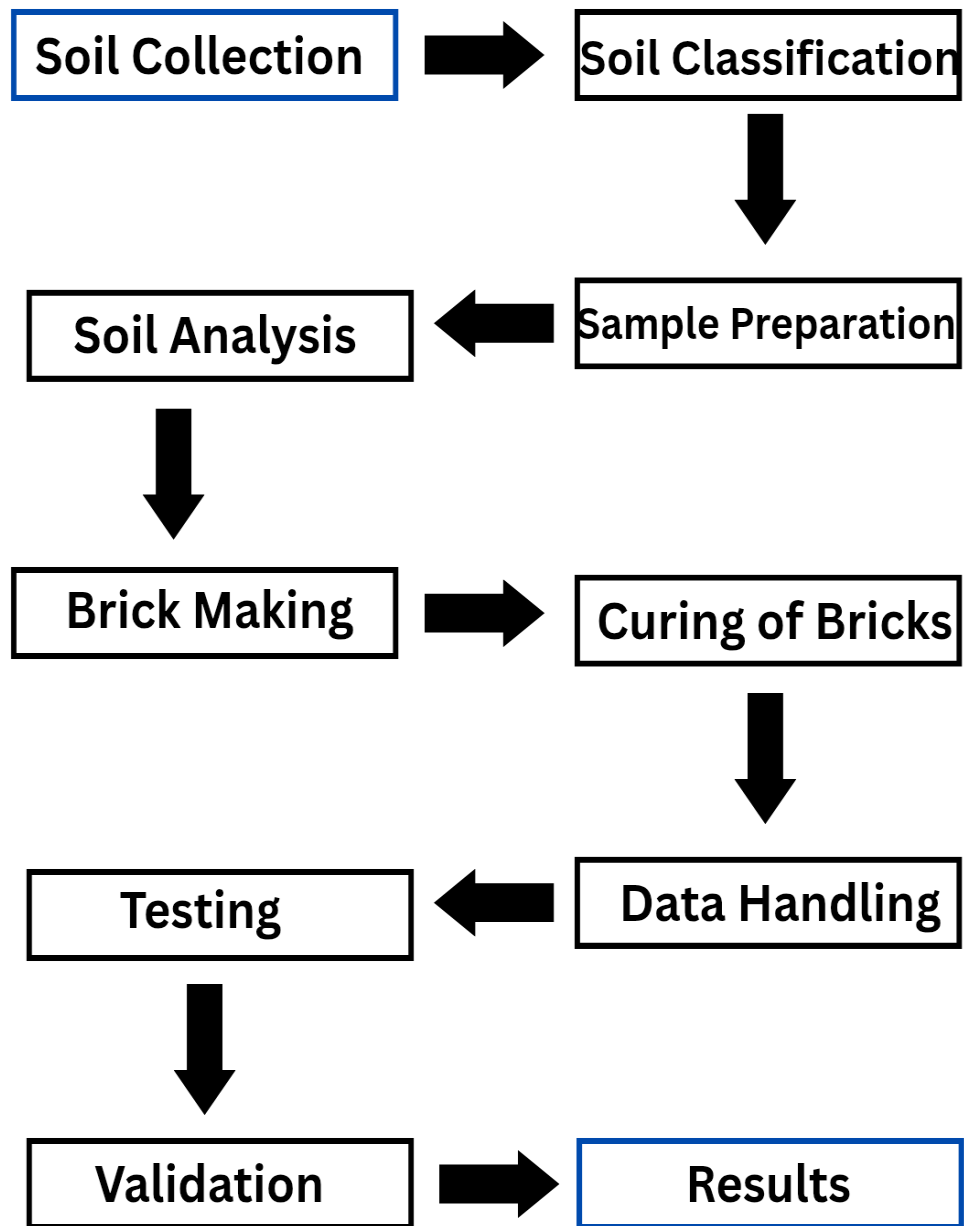


Figure 2: Research Flowchart

Data Gathering Procedures

The researchers started by reaching out to the Dean of Radiologic Technology and the Graduate Institute's Research Ethics Committee at Lorma Colleges to ask for permission to conduct the study. They carefully prepared the required documents and ensured that the study followed institutional and ethical guidelines. Once they received approval, they secured written consent to confirm their compliance with these rules. Afterward, the researchers approached local authorities in La Union to request approval for collecting soil samples from the chosen sites. They explained the study's purpose, identified the locations for collection, and described the steps they took to avoid any environmental harm. This process ensured that the study complied with local regulations and was carried out responsibly.

On the Gathering of Soils

The researchers gathered data in La Union due to its distinctive geological features that can provide effective lead alternatives for radiation shielding. Clay was purchased from the locals of Taboc San Juan, who collected it from the mountaintop of the San Juan Mountains, known for having a high clay content or natural deposits. Clay's dense structure made it a potential radiation attenuator. The sand samples were collected from the Balili River in Baraoas Sur, Naguilian, La Union. The loam soil used in the study was collected from Bangar, La Union, in shaded places where a lot of trees are present, and years of fallen leaves in those areas are decomposing and are being absorbed by the ground, which serves as natural composting.

On Checking Loam Soil Composition

The researchers brought a sample of 1kg of loam soil to the agriculture department in DMMMSU-NLUC for the soil experts to determine its composition. Samples were tested using the Retrometer method, wherein a hydrometer was used to determine its composition percentage of sand, loam, and clay.

On the Preparation of Soils

The collected soil samples, including sand, loam, and clay, were placed in clean, sterilized sacks to ensure they are secured and labeled appropriately with information such as the location, date, and soil type to facilitate easy tracking.

On the Making of Bricks Molder

The researchers created two brick molds, each producing six bricks at once. They started by setting up a clean, flat workspace with the help of a carpenter. The researchers measured and marked the plywood for two molds, ensuring each mold has six compartments, with each compartment measuring about 6 inches long, 4 inches wide, and 4 inches high. Using a saw, they cut the plywood into pieces for the sides, bases, and dividers for both molds. They then assembled each mold by arranging the pieces into rectangular shapes and adding dividers to create six equal compartments in each. A hammer and 1.5-inch nails were used to secure the pieces together, ensuring both molds are stable and properly aligned. Once finished, they inspected both molds for strength, reinforced them with extra nails, and labeled them. These molds were used to produce bricks that are complete and compacted.

On the Construction of Bricks

Three bricks were made for each ratio, resulting in a total of nine bricks for all three soil types. To make the bricks, the soil samples (loam, sand, and clay) were spread on a clean surface and mixed with 1 bag of cement in different ratios: 2:1, 1:2, and 1:3. Once the dry ingredients were well-mixed, water was added gradually. The amount of water was adjusted based on the texture, ensuring the mixture reaches a smooth, clay-like consistency without being too watery. The mixture was thoroughly combined to ensure even distribution of all ingredients. Next, the mixture was molded into slabs 4 inches thick to have uniform samples and ensure consistency for testing.

Molding is done in an orderly manner, and the mixture is pressed softly to have all air out of the mixture to maintain uniform density, ensuring the bricks are compact and solid. This step is essential in eliminating a commonly occurring weak point. The cured slabs are taken out of the molds after. These were checked for cracks or uneven surfaces. Damaged slabs were remixed, remolded, and re-cured as necessary to maintain uniformity. Then slabs were dried thoroughly to remove residual moisture, which is known to affect the performance of the slab when tested under radiation.

On the Curing of Bricks

After molding, the bricks were left to be cured and hardened for one week under the sun to allow the cement to set properly. The bricks were sprayed with water every day for seven days to make sure that they were hardened, due to the reason that the slower the concrete cures, the harder it is. This systematic process ensures the durability of soil-cement slabs. The area was monitored closely.

Once the bricks are fully hardened, each was labeled with important information about the specific soil used in the composition, the exact cement-to-soil ratio, and the date of its manufacture. Labeling was crucial for tracking and organizing the materials throughout the experimentation process. An appropriate storage room was provided to ensure the slabs and samples remained safe and secure throughout the process.

On Determining the Density of the Bricks

The bricks were weighed to determine their density, a key factor in assessing whether they can act as effective radiation shields. A higher density typically indicates that the bricks have the potential to absorb or block radiation. After weighing and determining the density of the bricks, they underwent X-ray testing. This step involved exposing the bricks to controlled X-ray radiation, and the amount of radiation absorbed or blocked by the bricks was measured.

On Radiation Absorption Testing

With the help of physicians, the accuracy of testing devices was checked to ensure reliable measurements. The laboratory of the Radiologic Technology Department at Lorma Medical Center in Carlatan, City of San Fernando, La Union, was designated for the X-ray machine, which was calibrated to ensure consistent output. Protocols for safety measures, including shielding and personal protective equipment, were also established.

The soil mixtures, together with a lead sample, are placed under the same controlled dose of X-ray radiation during the phase of conducting experiments. The 3 types of soil had 3 varying measurements, ranging from 1-3 kilograms each. Every sample had 3 bricks and was tested three times in an ascending order: 3 bricks for the first exposure, 2 bricks for the second exposure, and 1 brick for the third exposure. These three tests ensured the accuracy of the experiment. They were exposed to 70 kVp, 200 mA, and 4 mAs at 78 cm from the x-ray source, with the Fluke Model 451B-RYR Radiation Survey Meter monitoring at 88 cm from the x-ray source. The effectiveness in reducing the radiation was thus compared without variation. Baseline levels of radiation shall be established by measuring before exposure using a calibrated radiation detector. After radiation, the samples are again measured for their radiation levels, so the researchers can determine the amount of attenuation of radiation provided by the soil samples as compared to the lead.

All measurements of all experiments are documented in great detail, including environmental conditions such as temperature and humidity in which the experiments were performed. Any anomalies or any kind of unexpected events that might affect the results, such as equipment malfunctions or integrity variations in samples, are marked.

On the Organizing of the Data

The data was well arranged systematically, often using a spreadsheet or data

management software to make it easier for complete analysis and comparison regarding the effectiveness of soil types in reducing exposure to x-ray radiation compared with lead. The tests are designed to measure which of the soil-cement mixtures blocks and absorbs the X-ray radiation. From the results, the type of soil that, when mixed with cement, gives a relatively alternative for lead as radiation shielding based on density, composition, and thickness shall be determined. Statisticians were consulted to ensure proper data analysis, making the results accurate, reliable, and easy to compare. Additionally, comparing the findings with known data on the radiation shielding properties of other materials strengthened the study's validity and reliability.

To ensure its validity, the experiment was facilitated by a Radiation Safety Officer for compliance with the safety regulations and protocols, to make sure that the X-ray machine is in great condition, and to identify any potential hazards that may interfere with the experiment. A medical physicist measured the necessary technical factors to determine the accurate distance and best radiation detectors to use, and to evaluate the radiation exposure levels before and after radiation exposure. The researchers used instruments that are very sensitive to radiation, such as dosimeters or X-ray detectors that can measure the intensity of radiation both before and after it passes through the soil. The appropriate metrics used included attenuation coefficients or dose reduction percentages that directly indicate the level of absorption of radiation.

Additionally, researchers used external variables, which include background and scattered radiation, to be controlled for the measurements, only to imply the shielding ability of the soil. Comparing the results with other known data on radiation attenuation properties for other shielding materials enhanced the construct validity and hence the correctness of the findings. The researchers took consultations from civil engineers in the course to obtain specific information regarding structural and material properties of soil types. These are applied so that

handling and preparation, including the application of the samples to be prepared, are simulated in the actual environment of a situation.

The researchers acknowledged the fact that conducting multiple trials of X-ray radiation exposure ensured that the findings are reliable and accurate. This enabled the researchers to collect more comprehensive data that lead to a stronger basis for the conclusion of whether the soil was effective or not in terms of diminishing radiation. Moreover, trials conducted on various occasions helped to further confirm consistency, thus giving increased confidence to the results when it comes to the suitability of soil as a very viable, effective replacement for lead. In other words, such a method only proved the strength and validity of this study while supporting the aim of developing sustainable sources of protection from radiation.

The researchers utilized several standardized procedures to ensure that the findings were reliable. The researchers consistently used a method of preparing soil samples with the exact amount of soil composition and moisture. The researchers also performed controlled experiments within a controlled setting to avoid external influences from affecting the results. Using calibrated measurement instruments for radiation, the researchers were able to have an accurate X-ray attenuation reading. The researchers then applied statistical methods to the data so that the results are statistically significant and reproducible. Standardization is important in validating the findings of this research study and in contributing to the body of knowledge in radiation reduction techniques.

The researchers used some equipment to calibrate measurements. The researchers mainly took measurements using a radiation detector calibrated for the intensity of X-ray radiation before and after passing through the soil samples. The researchers also used a RaySafe ThinX RAD X-ray Meter and Fluke Model 451B-RYR Radiation Survey Meter for the monitoring of levels of radiation in the environment. This device was constantly checked against known sources

of radiation to validate accuracy. These instruments often required calibration to ensure reliable readings were obtained throughout the study; hence, the results and conclusions were strengthened.

Ethical Considerations

First, safety always came. Researchers ensured that those participating in the study did not have any X-rays directed at them. Such risks were strictly minimized. Also, the environment was treated with care. The collection and use of soil for testing need to be conducted carefully, not to harm the land, plants, or animals. Lastly, if the research requires consultation with the residents of the area or it requires collecting soil from particular regions, researchers enlightened them totally on the research and got permission from them before taking or using any soil.

Treatment of Data

To answer SOP 1, SOP 2, SOP 3, and SOP 4, a table was made that contains the following:

The Controlled Group was set first, baseline (column 3) was measured by exposing the radiation detector without any lead material shielding. The radiation rate after exposure and interpretation (columns 3 and 4) was measured after the exposure of a single and double layer of lead.

The experimental group was in the second table. Type of soil brick (column 1), under these are the mixtures of cement with different types of soils, namely: sand, clay, and loam. Ratio (column 2) is the measurement used in each mixture wherein 2 in the first ratio, 2:1 is the constant measurement of cement. Meanwhile, in the second ratio 1:2, and the third ratio 1:3, the constant measurement of cement is 1. This is to make sure that the 4x6x4 dimensions of the bricks are accommodated. Test number (column 3) is the number or order of repetition that the test has been done, the samples were labeled as T0 for the controlled group and T1, T2, T3 for the experimental group. The quantity of Bricks (column 4) is the number of bricks exposed to X-rays;

3 bricks shall be exposed on T1, 2 bricks for T2, and 1 brick for T3. The Baseline (column 5) is the Radiation rate measured before the exposure of bricks. The X-rays were directed to the Radiation detector itself without any brick covering it to compare the radiation rate measured before and after the bricks had been placed.

The source-to-object distance is 78 cm distance of the bricks away from the X-ray-radiation source. The source to radiation detector distance is 88 cm distance of the radiation detector (Fluke Model 451B-RYR Radiation Survey Meter) away from the X-ray source. Technical factors used are the constant 70kVp penetrating power, 200 mA, and 4 mAs, which is the quantity of useful x-ray beam. Finally, the identifying factor to know which soil type best absorbs X-ray radiation when it comes to the safety of the protective properties of soil, the radiation rate after exposure (column 6 and 7); this was the data gathered from the Fluke Model 451B-RYR Radiation Survey Meter which is the number of radiation that passed through the bricks in millisieverts (mSv), to quantify how much radiation could traverse the cured bricks, thus allows the researchers to compare the effectiveness of each material as a shielding agent. Radiation reduction levels were recorded for each sample, allowing for statistical comparison across different soil types and ratios. Radiation reduction levels were recorded for each sample, allowing for statistical comparison across different soil types and ratios.

The measurement rate of the Fluke Model 451B-RYR determined how safe the blocks are. If the radiation detector showed 80%-100 % radiation absorption, it has a high radiation absorption rate, thus, classified as safe. 70% - 79% radiation absorption rate is classified as moderate for better comparison. Lastly, a low radiation absorption resulting in less than 70% is classified as not recommended. This measurement rate helped the researchers identify which type of soil mixture best absorbs X-ray radiation, which one is safe and effective to use as a radiation shielding in the construction of a radiographic room.

The researchers utilized ANOVA as a statistical tool for this study to compare the X-ray absorption abilities of the 3 types of soil mixtures with their varying ratios, and a 4.34 t-value was used as the margin of error. This allowed the researchers to accurately determine which type of soil mixture best attenuates X-rays, and which ratio is the best mixture recommended to use in the structural design of a radiographic room. A control group was set which is a typical 0.5 inch lead sheet normally used in a radiographic room, this control group was placed 78 cm away from the radiation source and exposed to radiation with 70kVp, 200 mA, and 4mAS with the radiation detector 10cm away and just behind the brick, 1 layer of lead sheet for the first exposure and 2 Layers for the second exposure.

The experimental group was placed 78cm away from the radiation source, with the radiation detector 10cm away and just behind the sample. The radiation level that reached the detector was listed (Table 3). To ensure the reliability and accuracy of the experiment, the researchers prepared a total of 9 samples (bricks) with each type of soil, which would be 27 bricks in total. Thus, there were 3 samples for each ratio: 2:1, 1:2, and 1:3. This is due to the natural variation in the soil properties that are bound to exist. This should reduce the possibility of errors during measurements and obtain an average value reflecting the true behavior of the material tested, thus enhancing the accuracy of the result. It shall enable the researchers to ascertain the repeatability and reproducibility of the results obtained so that disparities in the diminution of radiation observed do not arise from differing sample preparation. With these, 3 samples each for the ratio, a total of 9 samples shall help in attaining better, valid, and significant data for the researchers' consideration when considering the soil as an alternative to lead in shielding radiation.

With this, the reproducibility of the researchers' observations is determined so that whatever effects observed can be consistently reported and are due to properties of the soil

rather than sample preparation variation. Generally, the use of multiple samples just added more validity to the researchers' conclusions since they provided more reliable data on the effectiveness of different soil ratios in radiation shielding. These results further expanded the researchers' understanding of the possibility of using soil as a reasonable, low-cost alternative radiation shielding material in comparison with conventional lead-based materials.

To facilitate the analysis process in answering SOP 1, SOP 2, SOP 3, and SOP 4 Tukey's Honest Significant Difference (HSD) test was utilized as a vital statistical tool to organize and analyze the data collected from testing the three soil types namely, clay, loam, and sand, at three different ratios, with three repetitions each. Thus, allowing the researchers to analyze and compare the X-ray absorption capacities of varying soil types, this statistical method is used to measure the significant differences between the means of multiple groups, which is needed to ensure strong analysis in identifying which specific groups differ significantly. Specifically, it enabled pairwise comparisons of the means of the various soil types and ratios, allowing researchers to determine which combinations result in the most significant absorption of X-ray radiation.

Furthermore, by using Tukey's HSD, researchers may ensure a constant level of significance across all comparisons, increasing the reliability of their findings. By first applying ANOVA to identify overall differences, Tukey's test provided detailed insights into which specific soil types exhibit significant absorption differences. This statistical tool is essential for ensuring accurate interpretations of the researchers' findings and contributes to the scientific accuracy of the study (Research Gate, 2021; Montgomery, 2020).

CHAPTER III

Results and Discussion

In this chapter, the data are presented in the form of tables that were statistically analyzed and interpreted to determine the absorption capacity of soil-cement mixture as an alternative for lead.

X-ray Radiation Absorption of Lead

Lead is one of the most effective materials used for radiation shielding because it absorbs X-rays and ionizing radiation. It is commonly used in radiographic rooms for walls, aprons, and shields to protect patients and healthcare workers from radiation.

The table below shows the results of the absorption level of the controlled group, lead, as a representation of the radiation shielding used in a radiographic room. 1 and 2 layers of lead with 0.5-inch thickness have been subjected to testing to compare the absorption of X-rays in different levels of thickness. The 200 mSv baseline radiation rate is the number of X-rays that reached the detector without any lead material blocking it. Any amount under the baseline radiation is 100% of X-rays; this serves as the basis of how much radiation the lead sheet has blocked. The radiation rate after exposure to lead in column 4 is the actual amount of radiation that successfully traversed the lead material, and in column 5 is the percentage of x-rays that the lead had absorbed. Column 6 shows the interpretation of the percentage of X-rays absorbed.

Table 1
X-Ray Radiation Absorption of Lead

Layers of Lead	Thickness	Baseline Radiation Rate	Radiation Rate after exposure	Percentage of X-rays Absorbed	Interpretation
Lead 1 Layer	0.5 inch	200 mSv	6.256 mSv	96.87%	Safe
Lead 2 Layers	0.5 inch	200 mSv	2.4 mSv	99.8%	Safe
Overall				98.33%	Safe

LEGEND: 80-100% SAFE; 70-79% MODERATE; <70% NOT RECOMMENDED

It was proven through the results that 1 layer of lead 0.5 inch thick, significantly blocked X-ray radiation from 200mSv to 6.256 mSv which resulting in 96.87% absorption. On the other hand, 2 layers of lead further reduced the amount of radiation to 2.4 mSv, resulting in 99.8%. With that being said, thicker lead shielding blocks more X-rays due to the concept that the intensity of the X-ray beam lessens as it passes through an object, however, both are safe to use for radiation shielding due to their high atomic number and high density, resulting in low radiation leakage.

It was reaffirmed that lead is a standard reference in radiation shielding effective against low-energy X-rays and gamma photons. According to Abualroos, Yaacob, and Zainon (2023), the authors have conducted some investigations on the radiation attenuation capacity of polymer-based shielding materials for gamma radiation. Although this research has been directed toward lead-free alternatives, it certainly reveals the superiority of attenuation efficiency of lead because of its much higher density and atomic number.

Radiation Absorption of the Soil-Cement Mixtures

Radiation absorption is simply how well a material can block or weaken radiation as it passes through. In this study, mixtures of soil and cement were tested to see how effective they are at protecting against radiation. Specifically, loam soil was mixed with different amounts of cement and shaped into bricks for testing. The ability of each mixture to absorb radiation depends on several factors, like the type of soil, how dense the bricks are, and how thick the material is. This experiment helps determine which combination offers the best protection from radiation.

The table below presents the results of the absorption level of the experimental group, particularly the Loam and cement mixture. Labeled loam 1, loam 2, and loam 3 for the 3 varying measurements of soil, ranging from 1-3 kilograms. Each loam sample was tested three times in an ascending order: 3 bricks for the first exposure, 2 bricks for the second exposure, and 1 brick for the third exposure.

From test 1 to test 3, soil samples of loam 1 had the highest absorption rate, ranging from 88.8% to 99.37%, showing consistency of being classified as safe. This implies that the measurement used here is the most recommended for radiation shielding. Test 3 of the remaining loam samples (loam 1 and loam 2) was considered not recommended for radiation shielding due to their low absorption rate of 17.85% to 43.70%.

Overall Loam sample is safe to use as a radiation shielding in thicker values. Test 1 for each loam sample with 3 bricks exposed was the most effective in absorbing x-rays, Test 2 also effectively blocked the x-ray radiation, however for Test 3 of loam 2 and 3 containing more loam soil, absorbed less radiation due to the smaller amount of cement binding the bricks which had high contributions to its density.

These findings were also reflected in Aditi Singla's work published in 2024, where she proved that the soil's property of absorbing radiation depends on its composition and type. So, apart from the findings concerning loam-cement mixture, she stated that sandy loam soil can absorb more radiation than any other soil type, such as sandy clay loam. This gives an edge for some soil compositions to be potential substitutes for radiation shielding whenever stabilized.

Table 2
X-Ray Radiation Absorption of Loam and Cement Mixture

Loam Sample	Ratio	Test Number	Quantity of Bricks	Baseline (Without Bricks)	Radiation Rate after exposure	Percentage of X-rays Absorbed	Interpretation
LOAM 1				250 mSv			
	2:1	T1	3		1.8 mSv	99.28%	Safe
	2:1	T2	2		2.4 mSv	99.04%	Safe
	2:1	T3	1		28 mSv	88.8%	Safe
TOTAL						95.70%	Safe
LOAM 2				270 mSv			
	1:2	T1	3		1.7 mSv	99.37%	Safe
	1:2	T2	2		3.6 mSv	98.66%	Safe
	1:2	T3	1		152 mSv	43.70%	Not recommended
TOTAL						80.57%	Safe

LOAM 3			280 mSv			
1:3	T1	3	1.8 mSv	99.35%	Safe	
1:3	T2	2	4.7 mSv	98.32%	Safe	
1:3	T3	1	230 mSv	17.85%	Not recommended	
TOTAL				71.84	Moderate	
OVERALL				82.70%	Safe	

LEGEND: 80-100% SAFE; 70-79% MODERATE; <70% NOT RECOMMENDED

In this part of the study, sand-cement mixtures were examined to assess their ability to serve as radiation shielding. Sand, when combined with cement and formed into bricks, showed consistently high absorption rates across different samples. This suggests that sand-based mixtures can be effective in reducing radiation exposure.

The table below presents the results of absorption levels observed in the experimental group. Soil samples of Sand 1, Sand 2, and Sand 3 are classified as safe from test 1 to test 3, having an absorption rate of more than 90%, excluding test 3 of Sand 3, which has a moderate absorption rate of 78.8%.

The sand sample is safe to use as a radiation shielding. For every test trial, this type of soil showed consistency in absorbing high amounts of radiation. Only test 3 of Sand 3, containing the most sand, was interpreted as moderate; this is due to the higher amount of sand, making it less compact and more potential spaces for the radiation to traverse the brick.

Finally, verifying the researchers' investigation are the findings of Temple in 2024, noting that sand, consisting of finely crushed particles, will create a protective shield against surrounding radiation. Sand is considered to have inherent properties that can serve as barriers for radiation exposure and afford protection in many industries. If properly applied as a lining material, it can attenuate the harmful effects of radiation on humanity.

Table 3
X-Ray Radiation Absorption of Sand and Cement Mixture

Sand sample	Ratio	Test Number	Quantity of Bricks	Baseline (Without Bricks)	Radiation Rate after exposure	Percentage of X-rays Absorbed	Interpretation
SAND 1				250 mSv			
	2:1	T1	3		1.7 mSv	99.32%	Safe
	2:1	T2	2		2.8 mSv	98.88%	Safe
	2:1	T3	1		15.7 mSv	93.72%	Safe
TOTAL						97.30%	Safe
SAND 2				240 mSv			
	1:2	T1	3		0.5 mSv	99.79%	Safe
	1:2	T2	2		2.9 mSv	98.79%	Safe
	1:2	T3	1		17.9 mSv	92.54%	Safe
TOTAL						97.04%	Safe
SAND 3				250 mSv			
	1:3	T1	3		1.7 mSv	99.32%	Safe
	1:3	T2	2		2.5 mSv	99%	Safe
	1:3	T3	1		53 mSv	78.8%	Moderate
TOTAL						92.37%	Safe
OVERALL						95.57%	Safe

LEGEND: 80-100% SAFE; 70-79% MODERATE; <70% NOT RECOMMENDED

In this study, clay mixed with cement was tested to see how effective it is for shielding against radiation. How well these bricks performed depended on several factors, like how thick they were, the ratio of clay to cement, and how dense the bricks turned out. All of these elements play a big role in how much radiation the material can absorb.

The table below presents the results of the absorption level of the experimental group, particularly the Clay and cement mixture. In all clay samples, tests 1 and 2 are the most recommended for radiation shielding due to their high absorption rate, showing consistency of being classified as safe. Meanwhile, test 3 of the clay samples, excluding clay 1, is considered unsafe due to their low absorption rate.

Overall clay sample is safe to use as a radiation shielding in thicker values. Test 1 and Test 2 for each clay sample with 3 bricks exposed were the most effective in absorbing x-rays; however,

for Test 3 of all clay samples resulted in a lower absorption rate because it contained more clay soil and a smaller amount of cement binding the bricks, which had high contributions to its density. In addition, the clay's properties are not as enhanced when mixed with cement compared to when it is baked in a kiln. As stated by Cayme, J. C. et al. (2021), the firing temperature is also crucial to the durability of the bricks due to the formation of different post-firing minerals, forming a network of sturdier crystal structures.

These findings are corroborated by Sakher et al.'s (2022) study, which shows that natural clay can be used as an environmentally responsible and efficient substitute for conventional shielding materials like concrete and lead. According to their findings, the X-ray attenuation rate was 99.79%, comparable to that of lead. Additionally, the authors emphasized that clay is much more readily available, non-toxic, and less expensive than metals like tungsten or lead.

This study is supported by Sagon and Surujpaul (2020), who demonstrated that blocks built of cement mixed with clay soil or white sand can be used for structural radiation shielding. The cement and clay soil mixture were found to be the most stable in terms of both structural qualities and radiation-blocking capacity, even though the cement and white sand mix had the maximum density and strength.

Table 4
X-Ray Radiation Absorption of Clay and Cement Mixture

Clay Sample	Ratio	Test Number	Quantity of Bricks	Baseline (Without Bricks)	Radiation Rate after exposure	Percentage of X-rays Absorbed	Interpretation
CLAY 1				210 mSv			
	2:1	T1	3		1 mSv	99.52%	Safe
	2:1	T2	2		2.5 mSv	98.80%	Safe
	2:1	T3	1		61 mSv	70.95%	Moderate
TOTAL						89.75%	Safe
CLAY 2				115 mSv			
	1:2	T1	3		1.3 mSv	98.86%	Safe
	1:2	T2	2		2.7 mSv	97.65%	Safe

1:2	T3	1	92 mSv	20%	Not recommended
TOTAL				72.17%	Moderate
CLAY 3		197 mSv			
1:3	T1	3	1.7 mSv	99.13%	Safe
1:3	T2	2	2.8 mSv	98.57%	Safe
1:3	T3	1	119 mSv	39.59%	Not recommended
TOTAL				79.09%	Moderate
OVERALL				80.33%	Safe

LEGEND: 80-100% SAFE; 70-79% MODERATE; <70% NOT RECOMMENDED

Table 5
Summary Table on the X-ray Absorption of the Soil-Cement Mixtures

	Type of Soil Brick	Percentage of X-rays Absorbed	Interpretation
A.	<i>Loam-cement</i>	82.70%	Safe
B.	<i>Sand-cement</i>	95.57%	Safe
C.	<i>Clay-cement</i>	80.33%	Safe

The table above shows that all soil-cement mixtures are capable of absorbing x-rays, with Sand-cement having the highest absorption rate of 95.57%. Loam-cement came second with an absorption rate of 82.70%. Meanwhile, Clay-cement had the lowest absorption rate of 80.33%. This means that Loam, Sand, and Clay are recommended as an alternative for lead.

The study of Sagon and Surujpaul (2020), proved that blocks built of cement mixed with clay soil and white sand has the ability to absorb X-rays. The cement and clay soil mixture were found to be the most stable and white sand mix had the maximum density and strength.

Radiation Absorption of Soil vs. Lead

The result of one-way ANOVA is 0.44 (F value) with a p-value of .8956, indicating that there is no significant difference between and among the groups. As can be seen by the averages or the mean values of the different groups in Table 6, the values are close to one another, thus, the results of the absorption rate of the controlled and experimental groups are comparable.

Meaning, the 3 different soil-cement mixtures: loam, sand, and clay can work as effectively as lead sheet in absorbing x-rays, thus, can be used as a standard walling for a radiographic room.

As seen on the table below, the mean of the experimental group is not far from the mean of the controlled group, aside from loam 2, loam3, clay 2, and clay 3 Trial 3, which fell behind the line. However, statistically, all of the groups have no significant differences among and between each other.

A. Safari and SMJ Mortazavi (2024) support these findings involving soil-cement as radiation shielding material instead of lead. Lead has been very commonly used because of its very high density and very good efficacy for blocking radiation; it is not only found in huge quantities, but also causes significant pollution and health hazards, as well as being very heavy. However, their concerns regarding toxicity, the environment, and weight have driven them to look for safer, lead-free alternative materials for these. This is supported by the findings of Safari and Mortazavi that soil, though porous, has exhibited good radiation attenuation properties, mainly due to its denseness, textural features, and chemical content. Their conclusion has heightened the emphasis on granulometric fractions, particularly clay content and the presence of oxides, regarding improving radiation shielding. Pires (2022) affirms that the soil's radiation attenuation ability is most dependent on density and material composition. These studies, therefore, conclude that soil-cement can be a better alternative safety shielding than the traditional lead sheet.

Table 6
Significant Difference between lead and soil-cement mixture

Source	SS	df	MS	F	p-value
Treatment	2,876.3891	9	319.59879	0.44	0.8956
Error	13,771.7024	19	724.79486		
Total	16,647.4915	28			

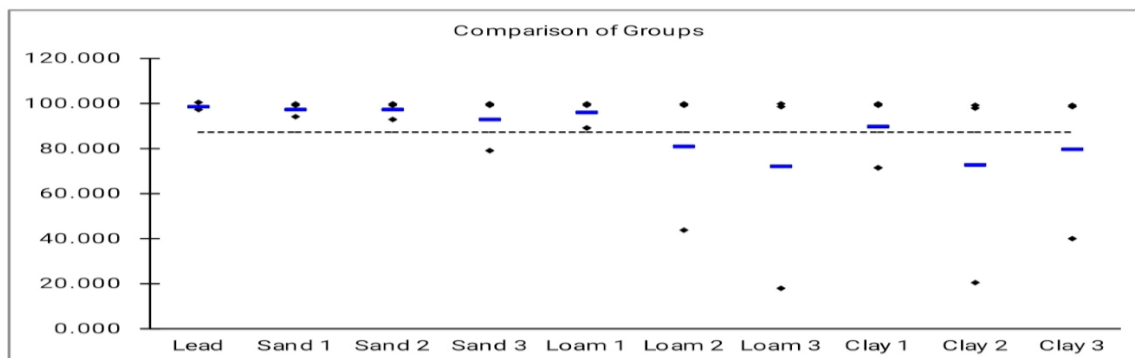


Figure 3: Comparison of Groups

Alternative for Lead Shielding

Table 5 shows that the sand-cement mixture in all ratios had the highest absorption rate of 95.57% of X-rays, making it the most recommended alternative for lead against X-ray radiation.

Rationale

Sand is abundant, and it is the standard soil of choice in constructing houses and infrastructures. When combined with cement, this type of mixture was the most compact, and because of this, it prevented the X-ray radiation from traversing the bricks. As stated by Grundy & Co in 2024, these individual grains are more angular than finer sands and interlock well when compressed, adding strength to projects and making them ideal for construction.

Bitrus et al. (2022) studied the X-ray shielding properties of concrete blocks made with varying proportions of sand and plastic. Their results corroborated the possible use of soil-cement as lead substitute, showing that while plastic enhanced attenuation, higher sand content would increase the mean free path. This confirms the tuning of sand-based cement mixtures towards effective X-ray shielding.

Objective

Using sand-cement mixture as an alternative X-ray radiation shielding is the first step in exploring different substitutes for lead in the construction of a radiographic room. This is a good replacement that could potentially lessen lead mining and protect the environment.

Scheme Process

The sand was collected at the Balili River in Naguilian, it was placed in a sack, labeled, and stored properly. After the collection of this type of soil, it was then measured, mixed with cement with water, and placed in a molder to form it into a brick. After the 9 bricks with three varying measurements of sand were made, the monitored curing of the bricks took place; it was sprayed with water every day for 1 week to make sure that the curing process would take longer for the bricks to become sturdy. Finally, it was tested using a radiation detector device.

CHAPTER IV

Conclusions and Recommendations

This chapter presents the conclusions drawn from the findings and the recommendations made based on the results of the study. The conclusions and recommendations focused on the main objective of the research, which is to determine the x-ray absorption capability of soil-cement mixtures as a potential alternative to lead for radiation shielding applications.

Summary of Findings

1. Lead served as the control material in the experiment. Based on the data collected, the average absorption rate of lead was 98.36% of x-ray radiation making it the standard for comparison due to its high-density shielding ability.
2. The results showed that combining loam and cement can be effective for x-ray radiation shielding. The loam 1, with 2:1 loam ratio performed the best. In all 3 trials, it absorbed 99.8%, 99.04%, and 88.8% of radiation, and was rated safe in every trial. The loam 2 with 1:2 ratio was effective in trials 1 and 2, blocking 99.37% and 98.66% of radiation. However, trial 3 only absorbed 43.70% and was no longer considered safe. The loam 3 at a ratio 1:3 also showed safe results in trial 1 and 2 with 99.35% and 98.32% absorption. But in trial 3, it dropped to just 17.85% making it unsafe.
3. The combination of sand and cement yielded a high absorption of x-ray radiation in all proportions and trials. The sand 1, with 2:1 sand ratio showed absorption of 99.32%, 98.88% and 93.72 % were shown to be safe in all trials. The sand 2, with 1:2 ratio gives an absorption rating of 99.79%, 98.79% and 92.54% are all safe ratings in all trials. The sand 3 at a 1:3 had an absorption rating of 99.28% and 99% in trials 1 and 2 which was rated safe, but trial 3 had absorption of only 78.8% which was rated moderate.
4. The clay-cement mixture produced mixed results in the trials. The clay 1, with 2:1 ratio was safe in trials 1 and 2 blocking 99.52% and 98.80% of radiation. But in trial 3 was

70.95% rated as moderate, showing a slight drop in performance but still usable. The clay 2, with 1:2 ratios give 98.86% and 97.65% are safe in trials 1 and 2. But in trial 3 was not recommended due to the poor absorption results which is 20%. The clay 3 with 1:3 ratios give 99.13% and 98.57% was safe in trials 1 and 2. But in trial 3 had absorption of only 39.59% making it unsafe. These findings highlight that while clay has potential as a shielding material, its performance heavily depends on thickness, compaction and preparation consistency.

5. All soil samples (loam 1-3, and 1-3, clay 1-3) showed no significant difference compared to lead in absorbing X-rays. This means their shielding ability was statistically similar to lead and the results confirmed that as the thickness increased, the materials absorbed more radiation, improving their shielding effectiveness.
6. Based on the trials, the sand-cement consistency showed high levels of x-ray absorption. Trial 1-3 of Sand 1-3, which are safe and highly recommended. However, trial 3 of sand 3 which is slightly lower and is therefore considered moderate but still acceptable as a shielding material.

Conclusions

1. Lead is a standard shielding material due to its high density, thus, provides a high X-ray radiation absorption rate.
2. All soil-cement mixtures (sand, loam and clay) can effectively absorb x-rays, and that the more compact the mixture, the higher its density and the better its radiation shielding ability.
3. There was no statistically significant difference between the soil-cement mixtures and lead, which supports the potential use of these materials in radiation shielding applications. As a result, these materials could provide safer, more sustainable, and

cost-effective option for radiation protection, especially in areas where access to traditional shielding materials is limited.

4. All soil samples (particularly sand, loam and clay with 2:1 ratio) demonstrated potential as alternative for x-ray radiation shielding and soil-cement mixture can be used as safer and more environmentally friendly substitute for toxic lead in radiation shielding.

Recommendations

1. The researchers recommend the soil type with the ratio that best absorbs X-ray radiation will be subjected to Civil engineers for validation of its structural integrity in the construction of a radiographic room, this ensures that the bricks are set to be used. It will be tested intensively to evaluate its durability for a long time, resistance against moisture, temperature, and degradation by environmental factors. Its compatibility with other construction materials will also be evaluated to determine whether it could be used along with standard building practices.
2. The researchers recommend that all soil samples (sand, loam and clay) must be sun dried and sieved for uniformity. Further studies should explore mix variations and assess the environmental impact of using soil-cement as a lead alternative.
3. As part of the durability process, the clay sample will be baked using kiln to harden it before use. This process ensures the clay reaches necessary strength and durability for construction purposes, enhancing its stability when used in radiation shielding structures such as bricks.
4. Civil engineers, as experts in structural integrity and construction standards will be responsible for thoroughly assessing its suitability for constructing radiographic rooms, ensuring the material meets all safety and stability requirements. Since this fall under

their area of expertise, they will validate its application in real-world construction scenarios.

5. The feasibility of double walling using the soil-cement mixture will also be explored to enhance shielding effectiveness and structural support.
6. Future research may assess shielding effectiveness across a range of radiation energy levels (both low and high kVp) to support wider applications in medical and industrial settings.
7. Future developments may also align with established national and international radiation safety standards.
8. To ensure reliability and accuracy of results, it is recommended that it replicates 3 times under consistent parameters. Future researchers may consider using enhanced or cooled x-ray equipment to minimize thermal limitations and to allow extended testing durations.
9. Additionally, the potential for large-scale production will also be checked to ensure that the soil is manufactured efficiently and effectively without compromising its shielding properties. A comprehensive benefit analysis will compare this alternative material with traditional lead barriers, environmental sustainability, and safety. These measures are aimed at establishing the soil type as a reliable, durable, and economical option for radiation shielding in medical and industrial applications.

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APPENDICES

APPENDIX A

Letter to the Adviser



LORMA COLLEGES
 Carlatan, City of San Fernando, La Union
COLLEGE OF RADIOLOGIC TECHNOLOGY



September 09, 2024

Michael John E. Flores
 Instructor
 College of Radiologic Technology

Dear Sir,

Greetings!

We, the undersigned third year students are conducting a research study entitled, "X-ray Absorption of Soil-cement mixture: An alternative for lead" in partial fulfillment of the requirements for our Research I course.

With regard to this endeavor, we are respectfully requesting your aid in becoming our **Research Adviser**. We are eager to start on this research journey under your guidance. Your expertise and mentorship are invaluable to us, and we look forward to receiving your feedback and recommendations. We seek your guidance, support, and valuable insights to help us refine our research approach and methodology.

We are hoping for your acceptance and approval.

Respectfully yours,

Krysha Hazel G. Bonnit

Carl Adrian M. Almoite

Lexie Anne A. Corpuz

Emil Marc M. Claro


Foral Cyd D. Tayaban

Carl Henry H. Soliven

Noted by:

Bernardo B. Tayaban JR.
 Research Instructor

Approved by:


Michael John E. Flores
 Research Adviser

APPENDIX B

Letter to Dean



Lorma Colleges
 Carlatan, City of San Fernando, La Union
 College of Radiologic Technology



March 17, 2025

Gryn T. Salagma, RRT, MPH
 Dean, College of Radiologic Technology
 LORMA Colleges
 City of San Fernando, La Union

Dear Ma'am,

Greetings! The undersigned are 3rd-year BSRT students of LORMA Colleges, currently conducting a study entitled "X-RAY ABSORPTION OF SOIL-CEMENT MIXTURE: AN ALTERNATIVE FOR LEAD." This research aims to explore innovative and sustainable alternative for lead material in blocking x-rays in the radiographic room through the utilization of soil-cement mixtures.

Lead mining and the product itself poses significant risks to public health and the environment. Therefore, the development of alternative materials that can effectively absorb x-rays is important. This study will investigate the potential of soil-cement mixtures to serve as an effective medium for x-ray absorption, focusing on their x-ray filtration ability, and environmental impact.

For this, we would like to seek permission to allow our currently working research paper to undergo ethical review by the Research Ethics Committee of LORMA Colleges. Thank you for your kind consideration, and we sincerely hope you will be able to fulfill our request.

Respectfully Yours,

ALMOITE, Carl Adrian M.

BONNIT, Krysha Hazel G.

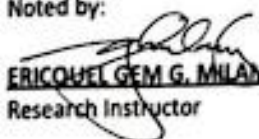
CLARO, Emil Marc M.

CORPUZ, Lexi Anne A.

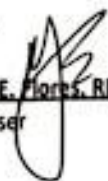
SOLIVEN, Carl Henry H.

TAYABAN, Foral Cvd D.

Noted by:


ERICOEL GEM G. MILANES, RRT
 Research Instructor

Approved by:


Michael John E. Flores, RRT, RSO, MSRT
 Research Adviser

APPENDIX C

Letter to Chairman of Graduate Studies & Research Institute



Lorma Colleges
 Carlatan, City of San Fernando, La Union
 College of Radiologic Technology



March 17, 2025

Marites C. Pagdilao, MAN, MPA-Chairman, CHS-GSRI

Chairman, Graduate Studies & Research Institute

LORMA Colleges

City of San Fernando, La Union

Dear Ma'am,

Greetings! The undersigned are 3rd-year BSRT students of LORMA Colleges, currently conducting a study entitled "X-RAY ABSORPTION OF SOIL-CEMENT MIXTURE: AN ALTERNATIVE FOR LEAD." This research aims to explore innovative and sustainable alternative for lead material in blocking x-rays in the radiographic room through the utilization of soil-cement mixtures.

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Your approval to proceed with this research project will be greatly appreciated. Thank you for your kind consideration, and we sincerely hope you will be able to fulfill our request.

Respectfully Yours,

ALMOITE, Carl Adrian M.

BONNIT, Krysha Hazel G.

CLARO, Emil Marc M.

CORPUZ, Lexi Anne A.

SOLIVEN, Carl Henry H.

TAYABAN, Foral Cvd D.

Noted by:


ERICQUEL GEM G. MILANES, RRT
 Research Instructor

Approved by:


Michael John E. Flores, RRT, RSO, MSRT
 Research Adviser

APPENDIX D

Letter to Chairman of Research Ethics Committee



Norma Colleges
 Carlaton, City of San Fernando, La Union
 College of Radiologic Technology



March 17, 2025

Ryan Jay G. Mostoles, MASE, RMT-Chairman, LC-REC
 Chairman, Research Ethics Committee
 NORMA Colleges
 City of San Fernando, La Union

Dear Sir,

Greetings! The undersigned are 3rd-year BSRT students of NORMA Colleges, currently conducting a study entitled "X-RAY ABSORPTION OF SOIL-CEMENT MIXTURE: AN ALTERNATIVE FOR LEAD." This research aims to explore innovative and sustainable alternative for lead material in blocking x-rays in the radiographic room through the utilization of soil-cement mixtures.

Lead mining and the product itself poses significant risks to public health and the environment. Therefore, the development of alternative materials that can effectively absorb x-rays is important. This study will investigate the potential of soil-cement mixtures to serve as an effective medium for x-ray absorption, focusing on their x-ray filtration ability, and environmental impact.

Your approval to proceed with this research project will be greatly appreciated. Thank you for your kind consideration, and we sincerely hope you will be able to fulfill our request.

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BONNIT, Krysha Hazel G.

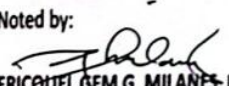
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CORPUZ, Lexi Anne A.

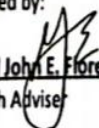
SOLIVEN, Carl Henry H.

TAYABAN, Foral Cvd D.

Noted by:


ERICQUEL GEM G. MILANES, RRT
 Research Instructor

Approved by:


Michael John E. Flores, RRT, RSO, MSRT
 Research Adviser

APPENDIX E

Letter to Hospital

LORMA COLLEGES



Carlatan, City of San Fernando, La Union
**COLLEGE OF RADIOLOGIC
 TECHNOLOGY**



Mr. Oliver T. Hufana
 Chief Radiologic Technologist
 Lorma Hospital

Dear sir,

We, a group of Radiologic Technology students from Lorma Colleges, are currently conducting a research study titled "X-Ray Absorption of Soil: An Alternative for Lead". This study aims to investigate the potential of different soil types as a cost-effective radiation shielding material.

In line with this, we are requesting permission to conduct our research within the X-ray Department of Lorma Hospital. Our study will involve controlled X-ray exposure to soil samples to measure their absorption capacity. We assure you that we will strictly adhere to all safety protocols and departmental guidelines throughout the research process.

Thank you for your time and consideration.

Respectfully yours,

Krysha Hazel G. Bonnit

Carl Adrian M. Almoite

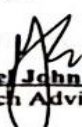
Lexie Anne A. Corpuz

Emil Marc M. Claro

Foral Cyd D. Tayaban

Carl Henry H. Soliven

Noted by:


Michael John E. Flores
 Research Adviser

NOTED BY OLIVER T. HUFANA

APPENDIX F

Letter to Statistician



LORMA COLLEGES
Carlatan, City of San Fernando, La Union
COLLEGE OF RADIOLOGIC TECHNOLOGY



May 19, 2025

Jerome P. Vera, LPT

Faculty, College of Education and Sciences

LORMA Colleges

City of San Fernando, La Union

Dear Sir,

Greetings with Lorma smile!

We, a group of Radiologic Technology students from Lorma Colleges, are currently conducting a research study titled "**X-Ray Absorption of Soil-Cement Mixture: An Alternative for Lead**". This study aims to investigate the potential of different soil types as an effective radiation shielding material.

In line with this, we would like to respectfully seek your assistance, expertise and time to be our **Statistician**. Your role would be to **verify the accuracy of the statistical computations** in our study and provide professional guidance on the interpretation of our experimental data.

Attached to this letter are the following for your reference:

- A soft copy of the statement of the problem and Hypothesis
- A Hard copy of collected from our experiment and integrity of our study

We are hoping for your positive response and support. Your contribution would be of great help in ensuring the accuracy and integrity of our study.

Thank you for your time and consideration.

Respectfully yours,

Krysha Hazel G. Bonnit

Carl Adrian M. Almoite

Lexie Anne A. Corpuz

Emil Marc M. Claro

Foral Cyd D. Tayaban

Carl Henry H. Soliven

APPENDIX G

Application for Ethics Review



LC-REC Form #010
APPLICATION FOR REVIEW FORM

APPLICATION FOR REVIEW

(Adapted from National Ethics Guidelines for Health and Health-Related Research 2017)

INSTRUCTION: Please accomplish the form and ensure that all necessary documents are included in your submission.

I. GENERAL INFORMATION:

Title of the Study: X-RAY ABSORPTION OF SOIL-CEMENT MIXTURE: AN ALTERNATIVE FOR LEAD

REC Code : _____ No. of Study Participants: N/A

Study Site : CARLATAN, CITY OF SAN FERNANDO, LA UNION

Name of Researcher/s: ALMOITE, Carl Adrian M., BONNIT, Krysha Hazel G., CLARO, Emil Marc M., CORPUZ, Lexi Anne A., SOLIVEN, Carl Henry H., TAYABAN, Foral Cyd D.

Contact Information : Telephone Number: _____]0- Mobile Number: 09620523364

Fax Number: _____ Email : kryshahazel.bonnit@lorma.edu

carlhenry.soliven@lorma.edu

emilmarc.claro@lorma.edu

foralcyd.tayaban@lorma.edu

lexianne.corpuz@lorma.edu

carladrian.almoite@lorma.edu

Name of Institution: LORMA COLLEGES

Institution's Address : CARLATAN, CITY OF SAN FERNANDO, LA UNION

Type of Study: Sponsored Clinical Trial Biomedical Research

Researcher-Initiated Clinical Trials Stem Cell Research

Health Operations Research Genetic Research

Social or Behavioral Research Others:

Public Health or Epidemiologic

Source of Funding : Self-Funded Scholarship/Research Grant

Government-Funded Institution-Funded

Sponsored by Pharmaceutical Company

Others:

Duration of the Study: Start Date: September 8, 2024 End Date: _____

Has the Research Undergone Technical Review? Yes No

APPENDIX H

Submission Checklist for Research



LC-REC Form #012
SUBMISSION CHECKLIST

SUBMISSION CHECKLIST

Name of Researcher/s: ALMOITE, Carl Adrian M., BONNIT, Krysha Hazel G., CLARO, Emil Marc M., CORPUZ, Lexi Anne A., SOLIVEN, Carl Henry H., TAYABAN, Foral Cyd D.

Title of Study: X-RAY ABSORPTION OF SOIL-CEMENT MIXTURE: AN ALTERNATIVE FOR LEAD

Name of Sponsor: _____

Date of Submission : March 10, 2025

Contact No.: 09167587462

Documents	Complete	Incomplete	Remarks
1. Letter of intent to conduct the study	_____	_____	_____
2. Filled-up Application for Review Form	_____	_____	_____
3. Endorsement of the Research Technical Panel (attach the Compliance Report)	_____	_____	_____
4. Title, Statement of the Problem/Objective	_____	_____	_____
5. Significance of the Study	_____	_____	_____
6. Literature Review	_____	_____	_____
7. Methods and Procedures	_____	_____	_____
8. Population and Locale	_____	_____	_____
9. Exclusion/Inclusion Criteria	_____	_____	_____
10. Data Analysis	_____	_____	_____
11. Questionnaire	_____	_____	_____
12. Funding Institution	_____	_____	_____
13. Timetable	_____	_____	_____
14. Ethical Considerations	_____	_____	_____
15. Curriculum Vitae of the Researcher/s	_____	_____	_____

by: _____
Signature Over Printed Name

Date: _____

APPENDIX I

Experiment Research Checklist

Checklist

STEP	TASKS	REMARKS
SITE SELECTION AND DATA COLLECTION	Confirm La Union as the data collection site	X
	Purchase clay from locals in Taboc San Juan	X
	Collect sand samples from Balili River, Baraoas Sur, Naguilan	X
	Loam soil will be collected from Bangar, La Union	X
SAMPLE PREPARATION	Secure clean, sterilized sacks for soil samples	X
	Label sacks with location, date, and soil type	X
STORAGE	Allocate safe storage for slabs and samples	X
	Ensure cleanliness and security of the storage area	X
LABORATORY SETUP	Designate lab space at Lorma Hospital for the experiment	X

	Calibrate the X-ray machine for consistent output	✓
	Implement safety protocols, including shielding and PPE	✓
BRICK FORMATION	STEP-BY-STEP PROCESS	
CLAY	Mix clay with cement in 2:1	✓
	Gradually add water to the clay and cement mixture (2:1) to achieve smooth consistency.	✓
	Place the clay mixture (2:1) into molds and press to remove air pockets	✓
	Mix clay with cement in 1:2	✓
	Gradually add water to the clay and cement mixture (1:2) to achieve smooth consistency.	✓
	Place the clay mixture (1:2) into molds and press to remove air pockets	✓
	Mix clay with cement in 1:3	✓
	Gradually add water to the clay and cement mixture (1:3) to achieve smooth consistency.	✓
	Place the clay mixture (1:3) into molds and press to remove air pockets	✓
LOAM	Mix loam with cement in 2:1	✓
	Gradually add water to the loam and cement mixture (2:1) to achieve smooth consistency	✓
	Place the loam mixture (2:1) into molds and press to remove air pockets	✓
	Mix loam with cement in 1:2	✓
	Gradually add water to the loam and cement mixture (1:2) to achieve smooth consistency	✓
	Place the loam mixture (1:2) into molds and press to remove air pockets	✓
	Mix loam with cement in 1:3	✓

	Gradually add water to the loam and cement mixture (1:3) to achieve smooth consistency	✓
	Place the loam mixture (1:3) into molds and press to remove air pockets	✓
SAND	Mix sand with cement in 2:1	✓
	Gradually add water to the sand and cement mixture (2:1) to achieve smooth consistency	✓
	Place the sand mixture (2:1) into molds and press to remove air pockets	✓
	Mix sand with cement in 1:2	✓
	Gradually add water to the sand and cement mixture (1:2) to achieve smooth consistency	✓
	Place the sand mixture (1:2) into molds and press to remove air pockets	✓
	Mix sand with cement in 1:3	✓
	Gradually add water to the sand and cement mixture (1:3) to achieve smooth consistency	✓
	Place the sand mixture (1:3) into molds and press to remove air pockets	✓
CURING	Sun drying of the bricks until it hardens	✓
	Store bricks in a controlled environment for curing	✓
	Maintain proper temperature and humidity in storage room	✓
	Ensure cleanliness of the curing area	✓
BRICK PROCESSING	Harden bricks completely	✓
	Grind bricks into 4-inch uniform	✓
	Labeled each brick with soil type, cement ratio, and production date	✓
	Weigh bricks to measure density	✓
X-RAY TESTING	Prepare bricks for x-ray testing	✓

APPENDIX J

REC Approval Letter



LC-REC Form #040
CERTIFICATE OF EXEMPTION FROM REVIEW


CERTIFICATION OF EXEMPTION FROM REVIEW

To: Carl Adrian Almoite, Krysha Hazel Bonnit, Emil Marc Claro, Lexi Anne Corpuz, Carl Henry Soliven,
and Foral Cyd Tayaban

From: LORMA Colleges - Research Ethics Committee

Date: March 25, 2025

This is to certify that the Research Proposal entitled, "X-RAY ABSORPTION OF SOIL - CEMENT MIXTURE: AN ALTERNATIVE FOR LEAD" submitted by Carl Adrian Almoite, Krysha Hazel Bonnit, Emil Marc Claro, Lexi Anne Corpuz, Carl Henry Soliven and Foral Cyd Tayaban of College of Radiologic Technology has been reviewed by the Research Ethics Committee of LORMA Colleges and found that all ethical considerations are in place to conduct the research in the stated locale of the study. Hence, this research proposal is exempted from review.


RYAN JAY G. MOSTOLBS, MASE, RMT
Interim Chairman, LC-REC

APPENDIX K

Progress Report



REC Form #014
PROGRESS REPORT FORM

PROGRESS REPORT

REC Code : _____

Title of Study: X-RAY ABSORPTION OF SOIL-CEMENT MIXTURE: AN ALTERNATIVE FOR LEAD

Name of Researcher/s: ALMOITE, Carl Adrian M., BONNIT, Krysha Hazel G., CLARO, Emil Marc M., CORPUZ, Lexi Anne A., SOLIVEN, Carl Henry H., TAYABAN, Foral Cvd D.

Name of Sponsor: NONE

Period of Report: _____ Contact No.: _____

I. Summary: *(Provide a short overview of the research – approved statement of the problem/research purpose/ hypothesis)*

Our research studies the viability of soil clay, loam, and sand as an alternative material to shield X-ray radiation. As the world faces increasing concerns about the high cost, toxicity, and environmental footprint of conventional lead shielding, it is important to seek more sustainable and affordable alternatives. Through the study of the X-ray absorption characteristics of these soils, the work seeks to assess their efficiency in attenuating radiation exposure. The results can offer significant insights into the viability of employing naturally available soil as a viable and environmentally friendly substitute in radiation protection, especially in resource-constrained environments.

II. Activities and Progress: *(Report on activities undertaken during the period covered by this report)*

Numerous events has taken place to accomplish the chapter 1 and 2 in the span of 4 months, from August 24, 2024 to December 21, 2024. Topic and title conceptualization was done first after the groupings was made, each member created a title which was passed to the Research instructor for recommendations. After the working title has been finalized, we searched for Review of Related Literatures dated 2019- 2024 which aligns with our study, as a result, we were able to write the Chapter 1 and was approved by our research adviser with few revisions, and writing of Chapter 2 came shortly. After much discussions and consultations, we were able to finalize our Research Proposal just in time for the presentation and title defense. On March 4, 2025 to March 17, 2025, our group filled up the REC forms and worked on revising the Research paper according to the recommendations of the dean, for the study to be officially approved by the chairman of the board of Judges, and after that the REC forms was passed. On April 1 to 11, the 27 soil-cement mixtures was made and it was set aside for curing, meanwhile soil samples of the three soil types were taken for texture analysis. On April 16, the fully cured bricks was exposed to X-rays with the help of a Radiation safety Officer and Medical Physicists.

III. Evaluation: *(Describe the overall progress of your research in terms of adhering to the timeline)*

Our research has progressed through several stages in accordance with our proposed timeline. We first submitted Chapters 1 and 2 to our research adviser, Sir Bernardo Tayaban, who provided insightful feedback that guided our preparation for the research proposal. However, during the proposal presentation, our study was not approved by the dean. We were advised to revise specific sections of Chapters 1 and 2, including suggestions for improving our research title. This led to a minor delay, but our group worked diligently to complete the necessary revisions. After making the corrections, we submitted the updated manuscript to our panelists. The revised version was approved, allowing us to move forward in the process. We finalized Chapters 1 and 2 and completed all required tasks on schedule, ready for submission to the Research Ethics Committee (REC). We successfully submitted the finalized manuscript and all required documents before the deadline. We are pleased to report that our group was approved to proceed to Chapter 3.

IV. Risks, Issues, and Challenges: *(State any issues, concerns or problems that hampered the development and progress of your study)*

In our study titled "X-ray Absorption of Soil-Cement Mixture: An Alternative for Lead," we encountered several risks, issues, and challenges, particularly with the availability and consistency of materials, as natural soil types like clay, loam, and sand varied in texture and composition, occasionally affecting our mixture ratios and experimental outcomes. Accessing x-ray facilities and accurately measuring radiation absorption levels posed additional difficulties, as scheduling time and ensuring proper calibration of the equipment led to delays in data collection. Safety concerns and proper handling of x-ray equipment required strict adherence to protocols and guidance from licensed radiologic technologists, adding complexity to our procedures, especially during repeated exposures. Furthermore, to ensure the reliability and reproducibility of our findings in comparing the soil-cement mixture to lead, we had to conduct multiple trials to minimize errors, which proved to be time-consuming.

V. Financial Updates: *(State the details of your expenditure so far)*

As of the current financial update in our research, a total of 4,425 pesos has been spent on various project needs. Specifically, 300 pesos was used to purchase a 1 sack of clay, while 2,000 pesos covered the overall transportation expenses. Soil testing was conducted for the three types of soil (clay, loam, and sand) costing 300 pesos each, totaling 900 pesos. An amount of 225 pesos was allocated for purchasing 1 bag of cement. For the bricks molder, which includes both the cost of the equipment and labor, 300 pesos was spent. Lastly, 1,000 pesos was used for printing needs, which covered ink, folder, paper clips and bond paper necessary for the manuscript and forms.

VI. Requests *(if there's any)*

VII. Next Steps: *(Briefly list the activities to be undertaken for the next stage of the research)*

After receiving approval from the Research Ethics Committee (REC), our group will proceed with the development of Chapter 3 and Chapter 4 of our study. Once the experiment was completed, we carefully organized all the gathered data to ensure it was ready for analysis. Our next step is to consult with a statistician to help us analyze the data accurately. These findings will form the basis of Chapter 4, where we will present and interpret the results in relation to our research objectives. Throughout this stage, we will continue to coordinate with our research adviser to ensure that our outputs are accurate, well-structured, and aligned with the overall goals of the study. Finalizing Chapters 3 and 4 will be a significant step toward the completion of our research.

ALMOITE, Carl Adrian M.,

BONNIT, Krysha Hazel G.,

CLARO, Emil Marc M.,

CORPUZ, Lexi Anne A.,

SOLIVEN, Carl Henry H.,

TAYABAN, Foral Cyd D.

(Signature Over Printed Name and Date)

APPENDIX L

Timetable

2024							
Task Name	Start Date	End Date	August	Sep.	Oct..	Nov.	Dec.
Topic & Title Conceptualization	8/26/2024	8/30/2024					
Review of Related Literature	9/08/2024	9/08/2024					
Letter to the Research Adviser	9/09/2024	9/09/2024					
Writing the Research Introduction	9/10/2024	9/17/2024					
Consultation for Research Paper Progress	10/6/2024	10/18/2024					
Accomplished Chapter 1	10/10/2024	10/13/2024					
Writing the Research Chapter 2	10/14/2024	10/21/2024					
Research Progress Consultation	11/08/2024	11/10/2024					
Finalizing the Paper	11/11/2024	11/29/2024					
Presentation of the Research Proposal	12/21/2024	12/21/2024					
2025							
Task Name	Start Date	End Date	Jan.	Feb.	March	April	May
Chapter 1 and 2 Revisions	1/13/2025	1/31/2025					
Panelist Consultation	2/10/2025	1/12/2025					
Finalizaing Chapter 1 and 2	2/13/2025	2/21/2025					
Submission of Manuscript	3/1/2025	3/6/2025					
Submission of Requirement for REC	3/9/2025	3/9/2025					
Feedback of REC	4/08/2025	4/08/2025					
Soil-Cement Production	4/09/2025	4/09/2025					
Curing of Bricks	4/10/2025	4/15/2025					
Exposing to Radiation	4/16/2025	4/16/2025					
Writing the Research Chapter 3 & 4	4/30/2025	5/13/2025					
Data Analysis	5/18/2025	5/19/2025					
Finalizing the Paper	5/19/2025	5/19/2025					
Presentation of the Final Defense	5/20/2025	5/20/2025					

APPENDIX M

Soil Analysis



DON MARIANO MARCOS MEMORIAL STATE UNIVERSITY
 Bacnotan, La Union, Philippines
 SERICULTURE RESEARCH AND DEVELOPMENT INSTITUTE
 www.dmmmsu.edu.ph | srdi@dmmmsu.edu.ph



RELEASED
 SRDI-RECORDS
 FO2-080
 DATE: 2025-05-14

SOIL AND PLANT TISSUE LABORATORY

Date Reported: 28 April 2025

Client: Henry Soliven

Affiliation/ Address: Lorma Colleges, San Fernando City, La Union

Analysis

Particle Size Distribution
 (Texture)

Test Method

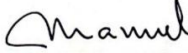
Hydrometer

RESULTS OF SOIL ANALYSIS


Control Number	Label	Particle Size Distribution			Texture Class
		% Sand	% Silt	% Clay	
280425-101	Loam	54	28	18	Sandy Loam
280425-102	Sand	86	6	8	Sand
280425-103	Clay	30	24	46	Clay


CHRISTIAN JAY P. WATSON

In-charge, Soil and Plant Tissue Laboratory


JANET D. MANUEL

OIC-Chief, Training and Technical
 Services Division


CRISTETA F. GAPUZ, PhD
 Executive Director, SRDI



APPENDIX N

DOST calibration certificate



Republic of the Philippines
Department of Science and Technology
PHILIPPINE NUCLEAR RESEARCH INSTITUTE

Certificate of Instrument Calibration

Reference Code: SM - MED - 2024 - 1264

The following instrument/s from
Customer Name : **MEDICAL PHYSICS & HEALTH PHYSICS SERVICES, INC.**
Address : Unit 211, The Manila Residences-Tower II, 2310 Taft Ave.,
Malate, Manila, Minerva R. Ebon
Contact : 8516-8233 / 09228767539

was calibrated at the Secondary Standard Dosimetry Laboratory of PNRI (PNRI-SSDL):

Field of Application	: Conventional Diagnostic Radiology
Type of instrument/detector	: Survey Meter / Ionization Chamber
Model	: 451B-DE-SI-RYR
Serial Number	: 2793
Probe Model	: none
Probe Serial Number	: none
Manufacturer	: Fluke Biomedical
Calibration Date	: December 02, 2024
Report Date	: December 04, 2024

METHOD OF CALIBRATION

The calibration was performed following the method in the International Atomic Energy Agency (IAEA) Safety Report Series No. 16. The instrument was calibrated for ambient dose equivalent, H*(10). The reference instrument, PTW/LS-01 32002 (S/N: 473), used to measure the air kerma output of the source is traceable to the International Bureau of Weights and Measures (BIPM). The standard source used is Cs-137 (Serial Number: 7404/19/091).

RESULT OF CALIBRATION

The calibration factor of the instrument is/are as follow/s:

Selector / Multiplier Switch	Calibration Factor (CF)
none	0.97

The response of the calibrated instrument is linear within the range of **0-50000** uSv/hr
The response of the instrument is within the acceptable limit **0.80 to 1.20**
The linearity of the instrument response is shown in Page 2.

Important Note: Use the calibration factor to determine the true reading of the instrument.

$$\text{True Reading, H}^*(10) \text{ (In } \mu\text{Sv/hr)} = \text{Instrument Reading (}\mu\text{Sv/hr)} \times \text{CF}$$

RECOMMENDATION

1. Check the battery before using the instrument, if applicable. Turn it off after use.
2. Conduct response test using a check source before monitoring.
3. Observe proper handling of the instrument.
4. Have the instrument calibrated periodically or after every repair to ensure accuracy of measurement. Please refer to relevant regulations for the prescribed calibration frequency.

Analyzed by:

Ave Ann Nikolle M. Garalde
AVE ANN NIKOLLE M. GARALDE
Laboratory Analyst

PNRI-SSDL-2024-1264

Please present certificate on the next calibration

Certified by:

Kristine Marie Romallosa Dean
KRISTINE MARIE ROMALLOSA DEAN
Head, Radiation Protection Services Section

RG2G

PNRI-RPSS-CAL-SM A
Rev 2 - 24 June 2022
CUSTOMER COPY
Page 1 of 2

Radiation Protection Services

APPENDIX O

Analysis

Table 8

Density of Bricks

Mixture Type	Dimensions	Ratio	Mass (Kg)	Volume (L x W x H)	Density (M/V)
Sand + Cement	4 x 6 x 4	2:1	3.25	96	0.033854166
		1:2	3		0.03125
		1:3	3		0.03125
Loam + Cement	4 x 6 x 4	2:1	2.5	96	0.026041666
		1:2	2.25		0.0234375
		1:3	2		0.020833333
Clay + Cement	4 x 6 x 4	2:1	2.75	96	0.028645833
		1:2	2.5		0.026041666
		1:3	2.5		0.026041666

Table 10

One Factor ANOVA

	Mean	n	Standard Deviation
Lead	98.360	2	2.1072
Sand 1	97.307	3	3.1139
Sand 2	97.040	3	3.9291
Sand 3	92.373	3	11.7559
Loam 1	95.707	3	5.9826
Loam 2	80.577	3	31.9381
Loam 3	71.840	3	46.7595
Clay 1	89.757	3	16.2910
Clay 2	72.170	3	45.1846
Clay 3	79.097	3	34.2149
Total	87.046	29	24.3835

Table 11

Summary of Analysis

	Lead t-value	Decision
Sand 1	0.04	No Significant Difference
Sand 2	0.05	No Significant Difference

Sand 3	0.24	No Significant Difference
Loam 1	0.11	No Significant Difference
Loam 2	0.72	No Significant Difference
Loam 3	1.08	No Significant Difference
Clay 1	0.35	No Significant Difference
Clay 2	1.07	No Significant Difference
Clay 3	0.78	No Significant Difference

Note: Critical value for t is 4.34 (level of significance is 0.01)

Table 12

Post HOC Analysis

	Loam 3	Clay 2	Clay 3	Loam 2	Clay 1	Sand 3	Loam 1	Sand 2	Sand 1	Lead
	71.840	72.170	79.097	80.577	89.757	92.373	95.707	97.040	97.307	98.360
Loam 3	71.840									
Clay 2	72.170	.9882								
Clay 3	79.097	.7449	.7561							
Loam 2	80.577	.6955	.7064	.9470						
Clay 1	89.757	.4251	.4336	.6333	.6809					
Sand 3	92.373	.3620	.3696	.5530	.5977	.9065				
Loam 1	95.707	.2912	.2977	.4591	.4996	.7896	.8811			
Sand 2	97.040	.2659	.2720	.4245	.4631	.7440	.8341	.9523		
Sand 1	97.307	.2610	.2670	.4177	.4559	.7350	.8248	.9427	.9904	
Lead	98.360	.2941	.2999	.4428	.4781	.7301	.8102	.9152	.9577	.9663

Note: p-values for pairwise t-tests

Table 13

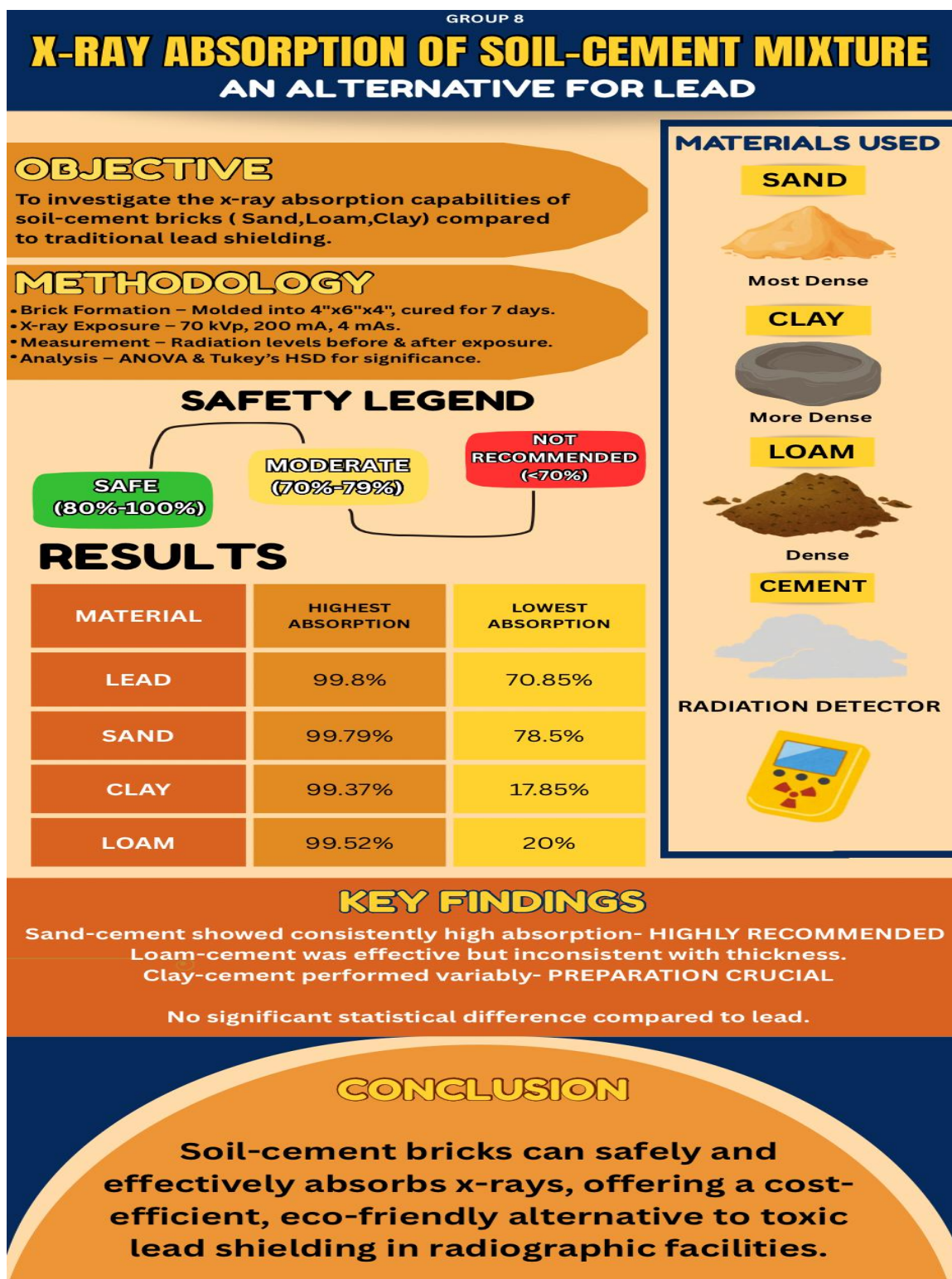
Tukey simultaneous comparison t-values (d.f. = 19)

	Loam 3	Clay 2	Clay 3	Loam 2	Clay 1	Sand 3	Loam 1	Sand 2	Sand 1	Lead
	71.840	72.170	79.097	80.577	89.757	92.373	95.707	97.040	97.307	98.360
Loam 3	71.840									
Clay 2	72.170	0.02								
Clay 3	79.097	0.33	0.32							
Loam 2	80.577	0.40	0.38	0.07						
Clay 1	89.757	0.82	0.80	0.48	0.42					
Sand 3	92.373	0.93	0.92	0.60	0.54	0.12				
Loam 1	95.707	1.09	1.07	0.76	0.69	0.27	0.15			
Sand 2	97.040	1.15	1.13	0.82	0.75	0.33	0.21	0.06		
Sand 1	97.307	1.16	1.14	0.83	0.76	0.34	0.22	0.07	0.01	
Lead	98.360	1.08	1.07	0.78	0.72	0.35	0.24	0.11	0.05	0.04

Note: critical values for experimental error rate (0.01 = 4.34)

APPENDIX P

Infographics



APPENDIX Q

Budget

Item	Cost (PHP)
Soil Samples	500.00
Molder	570.00
Transportation	2,000.00
Testing of Soil	900.00
Cement	225.00
Statistician	2,000.00
Stationery (Bond paper, Clips)	1,500.00
Research Proposal Printing	3,785.00
Research Defense Expenses	6,140.00
Total Estimated Cost	17,620.00

DOCUMENTATION

APPENDIX R
Documentation



Gathering Soils



Sack of Clay



Brick Molder & Other Materials



Weighing Scale & Plastic Basin



Hand Shovels



Cellophane Wrap



Markers



Measuring Cup



40 kg of Cement



Water Bucket with Dipper



Weighing Scale with Cement



Weighing Scale with Clay



Weighing Scale with Loam



Weighing Scale with Sand



Preparing Soil Samples



Mixing Water + Cement



Mixing Soil Samples



Leveling the Top of the Mold



Filling the Mold with Soil-Cement Mixture



Removing the Molder



Molded Brick



Molded Sample



Brick Drying in the Mold



All Samples are Molded



Curing of Bricks



Cured Bricks



Transporting for Testing



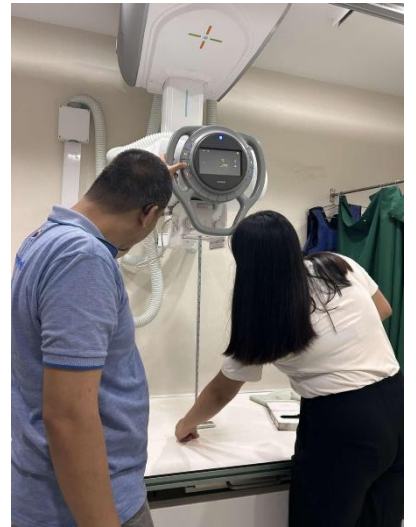
Fluke Model 451B-RYR Radiation Survey



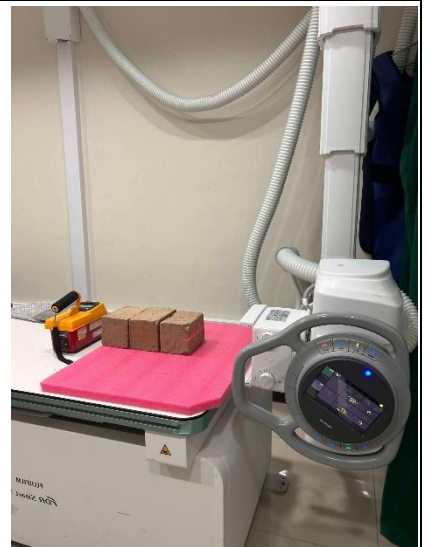
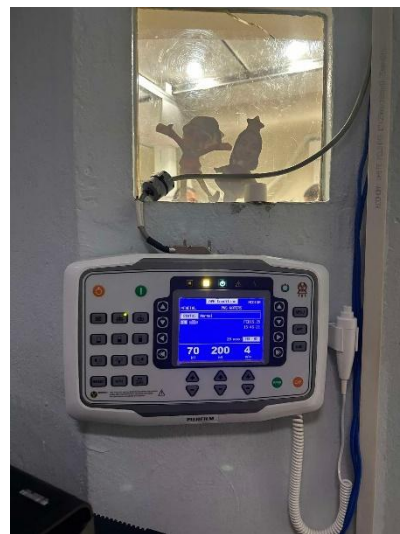
RaySafe Device



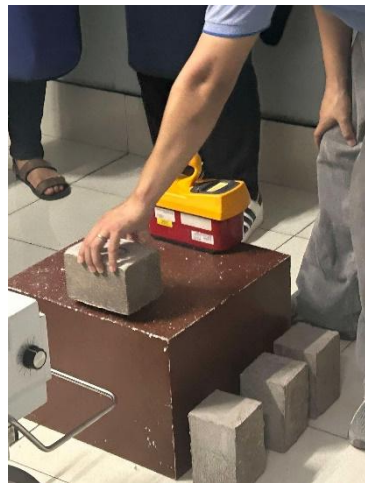
Checking the RaySafe Device



Setting up for Testing



During Radiation Exposure



CURRICULUM VITAE

2015-2017

Junior High School

Saint Christoper Academy

Central East 1 Bangar, La Union

Dona Francisca Lacsamana De Ortega Memorial

National High School

Primary

2007-2013 Elementary

Saint Christoper Academy

Central East 1 Bangar, La Union

III.AWARDS/CITATIONS/RECOGNITIONS RECEIVED: N/A**IV.WORK EXPERIENCE: SK KAGAWAD****V.ELIGIBILITY : N/A****VI.SEMINARS ATTENDED:**

	Municipal Anti-Drug Abuse Council
S.Y. 2024	Healing through Self-love: A journey of Self-Discover
S.Y. 2024	HIV and STDs: Prevention and Health Promotion
S.Y. 2024	Financial Literacy

VII. INVOLVEMENT IN RESEARCH/RESEARCHES CONDUCTED:**Quantitative Research (2019)**

Perceived Computer Literacy Skills of CSS Students of DFLOMNHS in Bangar La Union



LC-REC Form #003

CV TEMPLATE

CURRICULUM VITAE**BONNIT, KRYSHA HAZEL G.****I. PERSONAL INFORMATION**

Address : BANGBANGAR, BANGUED, ABRA
 Contact Number : 09620523364
 Email address : kryshahazel.bonnit@lorma.edu
 Date of Birth : MAY 11, 2004
 Place of Birth : CALABA, BANGUED, ABRA

II. EDUCATIONAL BACKGROUND

Tertiary **2022-Present**
 Bachelor of Science in Radiologic Technology Lorma Colleges
 Carlatan, City of San Fernando, La Union

Secondary **2016-2022**
 Science, Technology, Engineering and Mathematics
 Senior High School
 Abra High School
 Zone 1, Bangued, Abra

2016-2020

Junior High School

Abra High School—Special Science Class

Zone 1, Bangued, Abra

Primary

2010-2016 Elementary

Bangued West Central School

Zone 3, Bangued, Abra

III.AWARDS/CITATIONS/RECOGNITIONS RECEIVED

A.Y 2022-2023	SBO FIRST YEAR REPRESENTATIVE
A.Y 2022- 2023	DEAN'S LISTER
S.Y 2021-2022	With Honors
S.Y 2021-2022	Best in Research
S.Y 2020-2021	With Honors
S.Y 2019- 2020	With Honors
S.Y 2019- 2020	Special Science Class Survivor Award
S.Y 2019- 2020	Outstanding Performance in Research
S.Y 2019- 2020	Outstanding Performance in Arts
S.Y 2019- 2020	Outstanding Performance in Araling Panlipunan
S.Y 2019- 2020	Outstanding Performance in ESP
S.Y 2019- 2020	Outstanding Performance in Filipino
S.Y 2019- 2020	Outstanding Performance in Taekwondo
S.Y 2019- 2020	Catholic Women's League Awardee
S.Y 2019- 2020	Girl Scout Chairman
DSPC 2018	Radio Broadcasting Champion
RSPC 2018	Radio Broadcasting Champion
NSPC 2019	Radio Broadcasting Nationals qualifier
S.Y 2018- 2019	With Honors

DSMF 2019	Science Investigatory Project 3rd Place
DOST RICE 2019	Science Investigatory Project Qualifier
DSPC 2019	Radio Broadcasting Champion
RSPC 2019	Radio Broadcasting Champion
NSPC 2020	Radio Broadcasting Nationals qualifier
DSPC 2017	Radio Broadcasting 1st Runner Up
DSPC 2016	Radio Broadcasting 1st Runner Up
DSPC 2015	Radio Broadcasting Champion
DSPC 2014	Radio Broadcasting Champion
S.Y 2011- 2012	9th Honor
S.Y 2010- 2011	Best in Religion
S.Y 2009- 2010	Best in Religion

IV.WORK EXPERIENCE: N/A

V.ELIGIBILITY : N/A

VI.SEMINARS ATTENDED:

S.Y. 2024	Healing through Self-love: A journey of Self-Discover
S.Y. 2024	HIV and STDs:Prevention and Health Promotion
S.Y. 2024	Financial Literacy

VII.INVOLVEMENT IN RESEARCH/RESEARCHES CONDUCTED:

Quantitative Research (2022)

Multifunctional Small-scale Paper Pot Transplanter

Qualitative Research (2021)

Dilemma In The Compliance Of Requirements among STEM 11 Students of Abra High School

Quantitative Research (2020)

Anti-illegal Parking Alert and Warning System with Web App Notification

Quantitative Research (2019)

Efficiency of Fresh Water Shells (Apog) in the purification of Turbid Water



LC-REC Form #003

CV TEMPLATE

CURRICULUM VITAE**CLARO, EMIL MARC M.****I. PERSONAL INFORMATION**

Address : #22 SITIO HIGHWAY, DAL-LIPAEN, NAGUILIAN, LA UNION

Contact Number : 0 9 2 7 3 7 9 6 6 6 0

Email address : emilmarc.claro@lorma.edu

Date of Birth : FEBRUARY 1, 2001

Place of Birth : NAGUILAN LA UNION

II. EDUCATIONAL BACKGROUND

Tertiary **2022-Present**
 Bachelor of Science in Radiologic Technology Lorma Colleges
 Carlatan, City of San Fernando, La Union

Secondary **2017-2019**
 Science, Technology, Engineering and Mathematics
 Senior High School
 Naguilian National High School
 Imelda, Naguilian, La Union

2013-2017
 Junior High School
 Naguilian National High School

Imelda, Naguilian, La Union

Primary

2007-2013 Elementary

Cabaritan Elementary

III.AWARDS/CITATIONS/RECOGNITIONS RECEIVED

S.Y 2023-2024

DEAN'S LISTER

S.Y 2022-2023

DEAN'S LISTER

S.Y 2022- 2023

DEAN'S LISTER

IV.WORK EXPERIENCE: N/A

V.ELIGIBILITY : N/A

VI.SEMINARS ATTENDED: N/A

VII.INVOLVEMENT IN RESEARCH/RESEARCHERS CONDUCTED:

Quantitative Research (2019)

Hydro-fueled of Generator with Centrifugal Pump



CURRICULUM VITAE



CORPUZ, LEXI ANNE A.

I. PERSONAL INFORMATION

Address : BARAOAS SUR, NAGUILAN, LA UNION
 Contact Number : 09628751820
 Email address : lexianne.corpuz@lorma.edu
 Date of Birth : MARCH 24, 2004
 Place of Birth : BETHANY HOSPITAL, SAN FERNANDO, LA UNIOIN

II. EDUCATIONAL BACKGROUND

Tertiary **2022-Present**
 Bachelor of Science in Radiologic Technology Lorma Colleges
 Carlatan, City of San Fernando, La Union

Secondary **2020-2022**
 General Academic Strand (Health Allied)
 Senior High School
 Union Christian College
 City of San Fernando, La Union

Sacred Heart School
Central East, Bauang, La Union

Primary

2010-2016 Elementary

St. Augustine School

Naguilian, La Union

2009-2010 Kinder

Brgy. Ortiz

Naguilian, La Union

III. AWARDS/CITATIONS/RECOGNITIONS RECEIVED

A.Y 2010-2016

With Honor

A.Y 2010-2016

Conduct Awardee

S.Y 2015-2016

Girls Scout of the Year

S.Y 2016-2020

Conduct Awardee

S.Y 2016-2017

Cheer dance Competition (Champion)

IV. WORK EXPERIENCE: N/A

V. ELIGIBILITY : N/A

VI. SEMINARS ATTENDED:

S.Y. 2024

Healing through Self-love: A journey of Self-Discover

S.Y. 2024

HIV and STDs: Prevention and Health Promotion

S.Y. 2024

Financial Literacy

VII. INVOLVEMENT IN RESEARCH/RESEARCHES CONDUCTED:

Qualitative Research (2022)

Extent of Practicing Dietary among Senior High School Students



CURRICULUM VITAE



SOLIVEN, CARL HENRY H.

I. PERSONAL INFORMATION

Address : GABOR SUR, SANTA CRUZ, ILOCOS SUR
 Contact Number : 09544101730
 Email address : carlhenry.soliven@lorma.edu
 Date of Birth : NOVEMBER 23 , 2003
 Place of Birth : SANTA LUCIA, ILOCOS SUR

II. EDUCATIONAL BACKGROUND

Tertiary **2022-Present**
 Bachelor of Science in Radiologic Technology Lorma Colleges
 Carlatan, City of San Fernando, La Union

Secondary **2016-2022**
 Science, Technology, Engineering and Mathematics
 Senior High School
 Saint Augustine School
 Rizal, Tagudin, Ilocos Sur

2016-2020

Junior High School
 Saint Augustine School
 Rizal, Tagudin, Ilocos Sur

Primary

2010-2016 Elementary

Saint Augustine School
 Rizal, Tagudin, Ilocos Sur

2009-2010 Kinder

Saint Augustine School
 Rizal, Tagudin, Ilocos Sur

III.AWARDS/CITATIONS/RECOGNITIONS RECEIVED

A.Y 2016-2020

Parangal Awardee for Men's Volleyball
 Bronze Medalist for Provincial Meet
 Silver Medalist for Unit Meet
 Gold Medalist for Municipal Meet
 Altar Server Recognition Awardee

S.Y 2010- 2016

Parangal Awardee for Men's Volleyball
 Bronze Medalist for PRISAA Meet
 Silver Medalist for Municipal Meet

IV.WORK EXPERIENCE: N/A

V.ELIGIBILITY : N/A

VI.EMINARS ATTENDED:

S.Y. 2024	Healing through Self-love: A journey of Self-Discover
S.Y. 2024	HIV and STDs: Prevention and Health Promotion
S.Y. 2024	Financial Literacy

VII.INVOLVEMENT IN RESEARCH/RESEARCHES CONDUCTED:

Quantitative Research (2022)

“KALAHÍ”: Stories of acceptance and rejection among LGBTQIA+Community in Tagudin Ilocos Sur



CURRICULUM VITAE



TAYABAN, Foral Cyd D.

I. PERSONAL INFORMATION

Address : TA-O BAGUINGE KIANGAN IFUGAO
 Contact Number : 0 9 1 6 7 5 8 7 4 6 2
 Email address : foralcyd.tayaban@lorma.edu
 Date of Birth : DECEMBER 05, 2003
 Place of Birth : IFUGAO PROVINCE HOSPITAL

II. EDUCATIONAL BACKGROUND

Tertiary **2022-Present**
 Bachelor of Science in Radiologic Technology Lorma Colleges
 Carlatan, City of San Fernando, La Union

Secondary **2016-2022**
 Science, Technology, Engineering and Mathematics
 Senior High School
 Don Bosco High School
 Poblacion South, Lagawe, Ifugao

2016-2020

Junior High School

Don Bosco High School

Pob. East Lagawe Ifugao

Primary

2010-2016 Elementary

Lagawe Central School

Pob. East Lagawe Ifugao

III.AWARDS/CITATIONS/RECOGNITIONS RECEIVED**Interchool Sports Fesst 2024**Marching Band 3Rd Placer**A.Y 2020-2021**

DEAN'S LISTER

A.Y 2020- 2021

With Honors

S.Y 2019-2022

With Honors

S.Y 2018-2019

Academic Achiever (Top 18)

S.Y 2017CARAA 1st placer in Marching Band

IV.WORK EXPERIENCE: N/A

V.ELIGIBILITY : N/A

VI.SEMINARS ATTENDED: N/A

VII.INVOLVEMENT IN RESEARCH/RESEARCHES CONDUCTED:

Qualitative Research (2021)

Teacher and Student Perceptions of ICT Integration in Teaching and Learning