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Article

Socio-psychological analysis of the public perception of a contested infrastructure in Southwest Nigeria

Ayodeji Adekunle Eluyemi[1,2,*], Amos Adebimpe Amosun[2], Peter Adetokunbo[3], Tunji Omoseyin[4], Ogundele K. T.[1], Oluwabusayo Oluwakemi Eluyemi[5], Samuel Adedigba Adeojo[6]

[1] Division of Environment and Earth Science, Centre for Energy Research and Development (CERD), Obafemi Awolowo University (OAU), Ile-Ife 220005, Nigeria

[2] Applied Nuclear Science and Technology, Centre for Energy Research and Development (CERD), Obafemi Awolowo University (OAU), Ile-Ife 220005, Nigeria

[3] Maxima Geophysics LLC, Dallas, TX 75098, USA

[4] Department of Safety Sciences and Environmental Engineering, Indiana University of Pennsylvania, Indiana, PA 15705, USA

[5] Department of Sociology and Anthropology, Obafemi Awolowo University (OAU), Ile-Ife 220005, Nigeria

[6] Department of Physics and Engineering Physics, Obafemi Awolowo University (OAU), Ile-Ife 220005, Nigeria

*** Corresponding author:** Ayodeji Adekunle Eluyemi, ay_dot2006@yahoo.com

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Abstract: We investigated the perception of residents in southwestern Nigeria towards the establishment of a contested infrastructure, namely nuclear power plants (NPPs) and deep geological nuclear waste repositories. The study used an online survey methodology, encompassing 78 participants with a predominantly male composition (62%) and high educational attainment: postgraduate degrees (60%), graduate degrees (20%), undergraduate studies (18%), and secondary school certificates (2%). The research centered on "trust" as the primary independent variable, exploring its associations with factors, including fear, safety perceptions, and both local and foreign expertise. Statistical analysis using Pearson's correlation revealed robust positive relationships between trust in safety measures and NPP management ($r = 0.72$), as well as between trust and local expertise ($r = 0.60$). Significantly, fear regarding NPPs exhibited a strong negative correlation with support for their construction ($r = -0.70$), while trust in foreign expertise showed minimal correlations with other variables ($r \leq 0.2$). The respondents' professional backgrounds, primarily in physical sciences (45%), offered technically informed perspectives on nuclear infrastructure. The educational attainment of individuals showed a moderate positive relationship with knowledge of nuclear waste ($r = 0.57$), highlighting the role of education in determining perception of nuclear-related progress. These findings suggest that trust-building, particularly through local knowledge and safety assurances, while simultaneously addressing public fears, is critical to achieving public acceptance of NPPs and nuclear storage sites. It highlights the need for effective communication efforts and local experts being brought into the forefront in addressing the issues of public concern for nuclear infrastructural development.

Keywords: Pearson correlation; nuclear power plant; nuclear waste; deep geological repository; perception; fear; acceptance; safety

1. Introduction

The role of nuclear technology in our modern society goes beyond the creation of carbon-neutral electricity. Modern nuclear power reactors are now a vital source

of the global supply of low-carbon electricity, contributing about one-third of the total production of electricity of this nature, which translates to about 11% of the global production of electricity (Mathew, 2022). Its role becomes more vital as nations around the globe work towards their emission reductions of greenhouse gases as nuclear energy offers reliable baseload capacity to offset the variable nature of green energy resources (Hong et al., 2015; Lau et al., 2019; Michaelides and Michaelides, 2020). The further applications of nuclear technology in fields including medicine, industry, scientific research, and agriculture reinforce its role as a vital technology of our time.

The potential of this technology is demonstrated through continuous advancements that cover research into nuclear fusion, plasma science, and the creation of fast breeder reactors, thus highlighting their potential to meet future energy needs while reducing environmental pressures (Park and Ewing, 2023). Next-generation nuclear technologies such as small modular reactors (SMRs) are seen as promising options for nations looking to start or expand their nuclear power programs (Black et al., 2015; Ramana, 2021). In addition, new systems of thermal energy storage with nuclear reactors have been suggested to increase flexibility and efficiency in electricity production to meet the increasing reliance on clean energy options. Indeed, recent studies like those of Faizan et al. (2024) reveal promising advancements in nuclear power plants around the world.

Whereas countries like China and India are aggressively expanding their nuclear power programs, countries like Germany have opted to phase out nuclear power due to public concerns following the Fukushima disaster (Wang et al., 2020; Jang and Park, 2020) and the attendant significant risk it carries. These divergent trajectories reflect the interconnectivity of technical advance, public perception, and national decision-making at cross-purposes with one another. Uncontrolled exposure to nuclear radiation can have severe health implications, including the potential for serious illnesses and fatalities (Gale, 2017; Musa and Shabeeb, 2019). Moreover, the introduction of nuclear waste materials into aquatic environments can significantly disrupt ecological equilibrium (Reda et al., 2021; Yu et al., 2024).

The storage and disposal of highly radioactive materials such as spent nuclear power-generated fuels are one of the biggest challenges in the field of nuclear technology. According to recent studies, public acceptance of nuclear waste storage plants depends most often on the perceived pros and cons of the potential threats to the local populace (Xia et al., 2019). It is one of the complex technical and scientific problems in industrial countries around the world that requires innovative solutions for managing high-level as well as low- and intermediate-level radioactive wastes (Faybishenko et al., 2017; Ojovan and Lee, 2011; Stefanovsky et al., 2004). Up to now, the nuclear industry has not been successful in offering an integrated solution for spent fuels and high-level waste management.

Lack of such a solution contributes negatively to the future expansion of nuclear energy and further adds to the difficulties of promoting nuclear power as a means for solving climate change. While geological disposal is endorsed by many scientific and technical bodies as the preferred solution, significant uncertainties persist about the long-term performance of repositories and the behavior of nuclear wastes (Chenniappan

and Devarajan, 2024). Social acceptance of nuclear waste repositories has emerged as a critical factor in successful implementation, with studies showing that public trust in institutions and local stakeholder engagement significantly influence acceptance levels (Bronfman and Vazquez, 2011; Liu et al., 2018).

Countries have followed conflicting strategies, with some like Finland, Sweden, and France opting for deep permanent disposal, while others like Japan, the UK, and India propose spent nuclear fuel reprocessing (Kim et al., 2023). The success of the Onkalo repository project in Finland underlines the importance of sustained public engagement and open decision-making processes in facilitating social acceptance (Konsti-Laakso and Rantala, 2018). Innovative technologies such as thermal plasma melting are being explored for more effective and environmentally friendly radioactive waste disposal (Ma et al., 2024).

The complexities surrounding public engagement in nuclear waste repository site selection, along with the intricate interplay between trust, perception, and public benefit, have been extensively investigated in numerous studies. Recent studies have underscored the influence of cultural values and social trust on public attitudes toward nuclear facilities (Whitefield et al., 2009). Empirical evidence has indicated that risk perceptions and confidence in strategies for managing risks are major factors that shape the resistance of the public to nuclear waste repositories (Flynn et al., 1992; Pijawka and Mushkatel, 1991). Longitudinal studies illustrate that public opinion is not static and is influenced by several factors, thereby focusing arguments on underlying values and responsibility by enhancing its perceived usefulness (Hoti et al., 2021; Roh, 2017; Xue et al., 2024). It appeals to build trust with the public through transparency, assurance of preservation and sustainability of information, and making institutional reputation a focal issue (Kunreuther et al., 1990; Parayitam and Dooley, 2009).

In the Nigerian setting, some technical works have examined different areas of siting a nuclear power plant, which include seismotectonic stress studies by Eluyemi et al. (2019), the study of Geographic Information System (GIS)-based site suitability by Eluyemi et al. (2020a), and a preliminary study on earthquake-safe site locations by Eluyemi et al. (2020b). However, a wide knowledge gap still exists regarding socio-psycho-political research relating to public acceptance studies of nuclear power plants and deep geological repositories. This paper attempts to fill this knowledge gap through an investigation of local perceptions of nuclear infrastructure using a statistical analysis of online survey data. Furthermore, it also investigates public responses to the potential benefits of infrastructure development. It is hoped that the outcome will feed into government policy formulation and uncover local attitudes toward the development of nuclear infrastructure, hence contributing to the betterment of public engagement strategies and policy design.

2. Evolution of Nigeria's energy infrastructure

Nigeria's power infrastructure has developed considerably since independence from a nearly wholly hydroelectric scheme to a more mixed energy framework comprising thermal, gas, and renewable energy sources (Oyedepo, 2012). Southwest Nigeria, being the country's industrial and commercial center, has persistently

experienced increasing power demands outpacing supply, leading to long-term power shortages that have hindered economic growth (Emodi and Yusuf, 2015). The zone is dependent on gas-fired power stations, such as Egbin (1320 MW) and Olorunsogo (335 MW), which provide high percentages of the nation's grid capacity but are not yet adequate to satisfy regional needs (Aliyu et al., 2013).

In response to these, Nigeria's energy master plan has progressively emphasized the need for diversification from fossil fuels, leading to the establishment of the Nigeria Atomic Energy Commission (NAEC) in 1976 and the Nuclear Power Program Implementation Committee in 2007 (Oluseyi et al., 2016). This policy thrust led to proposals for Nigeria's maiden nuclear power plant, with Geregu in Kogi State (Nigeria's southwestern border) being one of the probable sites, alongside other possible sites such as Itu in Akwa Ibom State and locations in Kastina and Sokoto. The government of Nigeria has promoted nuclear energy as a panacea for Nigeria's chronic electricity deficits based on such benefits as low carbon emissions, foreign energy independence, and economic growth (Ajayi and Ajanaku, 2009).

Nuclear installations are a new and especially contentious class. The planned Geregu Nuclear Power Plant has been the subject of considerable controversy since its proposal. Unlike older energy infrastructure that was protested largely on grounds of land acquisition and immediate environmental effect, nuclear installations bring in long-term safety, radioactive waste disposal, and technological sophistication concerns that are comparatively new in the Nigerian experience (Ejiogu, 2013).

In addition to nuclear electricity generation, the related issue of the disposal of radioactive wastes by deep geological burial is yet another cause of controversy. Although no particular repository sites have been formally suggested in Nigeria, international practice indicates that such facilities are likely to attract even more intense opposition than the power stations themselves (Ogunseitan, 2015). Public knowledge about the science of nuclear waste isolation is shallow, and such a deficiency of information may have a determining effect on risk perception (Chung, 2008; Kemp, 1990).

3. Socio-cultural context of technology acceptance in Southwest Nigeria

There are several circumstances that shape public opinion regarding disputed infrastructure, particularly nuclear installations:

- Confidence in governance and regulatory frameworks:
  Southwest Nigeria has long held relatively ambivalent attitudes towards federally controlled projects, echoing wider political dynamics. This ambivalence is also directed towards doubts regarding regulatory capacity for advanced technology such as nuclear energy, with uncertainty as to whether Nigeria's institutional infrastructure can provide assurance of comparable safety standards to developed countries (Agbonifoh and Elimimian, 1999; Afieroho et al., 2023).
- Access to information and education:
  The southwest of Nigeria has the highest literacy and media penetration, which

is both an opportunity and a challenge for public participation in complex infrastructure. Although citizens are more exposed to information, they are also subjected to global narratives of nuclear accidents that exaggerate risk perception (Huang et al., 2013).

- Intergenerational perceptions:
  Various age groups may vary in their perceptions of nuclear infrastructure, with older generations placing greater emphasis on short-term economic gains and younger, more internationally integrated generations possibly placing greater emphasis on long-term environmental effects and safety.
- Environmental justice and environmental management history:
  Among the key determinants of public opinion about nuclear installations in Southwest Nigeria is Nigeria's tumultuous past with respect to the control of environmental effects of large-scale industrial operations. Environmental justice issues are especially relevant considering Nigeria's past experiences with environmental devastation linked to the exploration of energy resources, most notably the widespread oil pollution of the Niger Delta region. Even with the fact that Nigeria's oil industry has been in existence for more than 60 years, adequate environmental protection and complete remediation work have not been achieved, while the study by the United Nations Environment Program (UNEP) of Ogoniland showed contamination to groundwater and soil much deeper than has previously been tolerated, which would take 25–30 years to clean up (UNEP, 2011). This record generates deep-seated skepticism regarding the possibility of a technology so advanced and dangerous as nuclear power being better managed.

  The regulatory failings in the oil sector quite rightly raise legitimate questions about Nigeria's institutional capacity to enforce safety standards for nuclear facilities. Critics point to systemic problems like lack of technical capacity, weak oversight capability, regulatory capture, and corruption as problems that have undermined environmental governance in the oil sector (Obi, 2010). This skepticism is even stronger in Southwest Nigeria, where educational levels and access to information are higher and provoke greater sensitivity to perceived risks. Citizens wonder whether their countries can effectively implement the strict monitoring required of nuclear facilities when other regulatory bodies have failed to ensure environmental quality in less technologically advanced industries (Mathai, 2013; Sovacool and Valentine, 2010).

  It is necessary to understand these contextual factors in order to make sense of public opinion about controversial infrastructure in Southwest Nigeria. Although there has been research that has investigated infrastructure acceptance in Nigeria generally (Adama, 2018), insufficient attention has been given to the particular case of nuclear facilities and repositories in the southwest, and thus the knowledge gap that this research fills. Through an analysis of opinion on nuclear power plants and deep geologic repositories, this study offers an analysis of how Southwest Nigeria's singular history, culture, and socioeconomic environment influence opinions on these most prominently controversial forms

of infrastructure.

4. Methodology

A quantitative research design using an online survey methodology was employed to assess public perceptions relating to the infrastructure of nuclear power plants in Nigeria. Data were collected through a structured questionnaire administered to literate Nigerian citizens. The questionnaire, accessible via Google Forms at https://tinyurl.com/hvm2ae4m with responses available at https://tinyurl.com/mr49sspd, we gathered comprehensive demographic information and specific variables relating to nuclear infrastructure perception.

The survey instrument was structured into four main sections. The first part solicited information on demographic data such as age, gender, educational attainment, and occupation. The age groups were designed in cohorts: 20–29, 30–39, 40–49, 50–59, and > 60 years. The educational attainment was categorized into six levels: secondary school certificate, undergraduate student, graduate degree, postgraduate degree, and others. Occupational categories included physical scientists, environmental scientists, medical scientists, social scientists, students, and others to analyze expertise-based perspectives.

The second part measured the previous knowledge and perception about nuclear facilities using a set of Likert-scale questions (1–5, where 1 represents very low and 5 represents very high). These included variables relating to knowledge of nuclear power plants, understanding of nuclear waste management, and familiarity with deep geological repositories. The third part consisted of trust-related variables, namely, trust in safety measures, trust in NPP management, and finally, confidence in local and foreign expertise. All the above-mentioned variables had been measured by a 5-point Likert scale.

The fourth part measured public acceptance and concern. The main variables for measurement were support for NPP construction, fear level about nuclear facilities, preference for involvement in siting decisions, attitude towards compensation. Complementing these, other questions regarding the preferred expertise for project implementation and trust in oversight by the federal government were also considered.

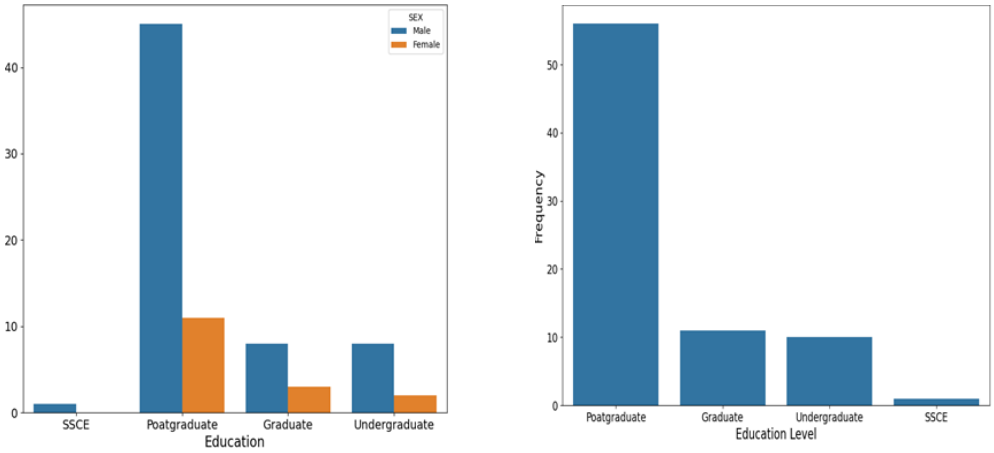
The statistical analysis was multi-stage. First, descriptive statistics for all demographic variables were calculated. Demographic profiles and response patterns were visually represented using bar charts and histograms. Data were stratified by age groups to conduct age-based analyses in order to determine generational patterns in the level of trust and acceptance. Pearson's coefficient for correlation analysis was done against major variables. Trust-related variables particularly, in correlation with demographic and acceptance indicators. The statistically significant level (p-value) for the correlation was set at below 0.01.

The analysis also examined associations between expertise, both local and foreign, and public trust; the effect of educational background on knowledge about nuclear waste; and the relationship between fear and opposition to nuclear facilities. Further analysis tested the dependence of trust in NPP handling and siting decisions on professional affiliation.

Responses were further checked for completeness and coherence. Partial responses have been excluded from the final analysis. Limitations regarding the sampling methodology were minimized by considering respondents various educational and professional backgrounds.

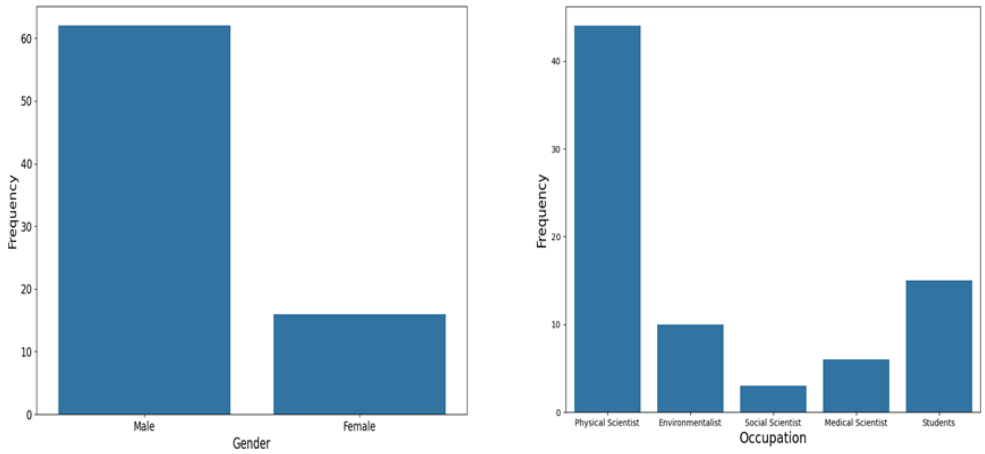
5. Result and discussion

Analysis of the data from a survey conducted with 78 participants demonstrates significant trends related to demographic profile and attitude towards nuclear plants. Demographically, the distribution within the sample accounted for 62% men and 38% women. In relation to education level, the data demonstrates that 55% had postgraduate degrees, 13% had bachelor's degrees, 12% were undergraduates, 2% had secondary school diplomas, and 18% fell into the category of others (see **Figure 1a,b**). In the distribution of professions, physical scientists predominated with 45%, with others being students with 15%, environmental scientists with 10%, medical scientists with 5%, and social scientists with 3%, and the final 22% being made up by miscellaneous professions (see **Figure 2**).



(a) **(b)**

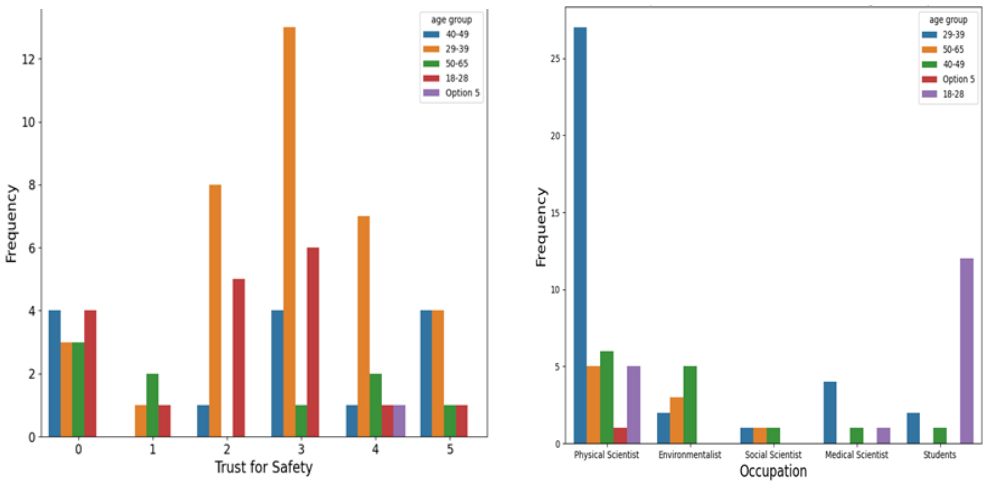
Figure 1. Bar chart representation of: **(a)** the educational distribution based on gender of the respondents; **(b)** educational level distributions of the respondents.



(a) **(b)**

Figure 2. Bar chart representation of: **(a)** the gender distribution and; **(b)** associated occupations of the respondents.

Statistical investigation into perceptions of safety among age cohorts showed an important divergence in response patterns. In the group aged 29 to 39 years, 54.2% reported an intermediate level of trust and 29.2% reported high levels, with 16.7% reporting very high levels of trust. The 40- to 49-year-old group showed the bimodal distribution with 33.3% being located on either extreme on the measure of trust, as shown by **Figure 3a**. **Figure 3b** shows the distribution by age and by occupational category and reflects that physical scientists were most prominently located in the 29 to 39 years category and represented 38.5% of this group. Environmentally focused scientists were most represented in the 40 to 49 years category, representing 25% of this demographic.



(a) **(b)**

Figure 3. Bar chart representation of: **(a)** trust for safety based on the age group of the respondents; **(b)** occupation of the respondents and their respective age group.

The demographic breakdown by age showed significant differences in levels of trust regarding the handling of nuclear power plants. The data showed 42.3% among those aged 29 to 39 having medium levels, and in sharp contrast, 18.7% with very high levels of trust. In the 40- to 49-year-old group, both very high-trust and very low-trust individuals were represented in equal proportions at 35.7% (**Figure 4**). Analysis of the professional background showed that physical scientists showed more consistent patterns of trust among all age groups, with 65% reporting moderate to high levels of trust. Environmental scientists showed more variability in reporting levels of trust, and an approximately equal split occurred along this continuum. Medical scientists mostly reported moderate levels, with 75% in this category, and social scientists showed relatively lower overall levels of trust.

The correlation analysis performed by the use of Pearson's coefficient identified a number of significant relationships (**Figure 5**). The highest correlation value observed for trust in safety measures was 0.72, and it was related to trust in NPP management. This correlation was stable across age and educational groups. In addition, trust in local expertise was positively correlated with trust in safety, $r = 0.53$, $p < 0.01$; and with trust in NPP management, $r = 0.60$, $p < 0.01$, with both correlations being stronger in those with higher educational attainment. Fear related to NPPs was negatively correlated with support for NPP construction, $r = -0.70$, $p < 0.01$, more significantly so in the

younger age group (20–39 years). Higher education was positively correlated with knowledge on nuclear waste, r = 0.57, $p < 0.01$; postgraduates scored the highest on knowledge, with a mean of 4.2 on a 5-point scale. It is interesting to mention that trust in foreign expertise had low correlations with all variables: $r \leq 0.2$, $p > 0.05$, irrespective of demographic differences. The correlation between trust in NPP management and public participation in siting decisions had a negative trend, r = −0.53, $p < 0.01$; the trend was strongest in the group of respondents who had scientific occupations, giving an impression that increased involvement in decision-making processes could influence trust levels.

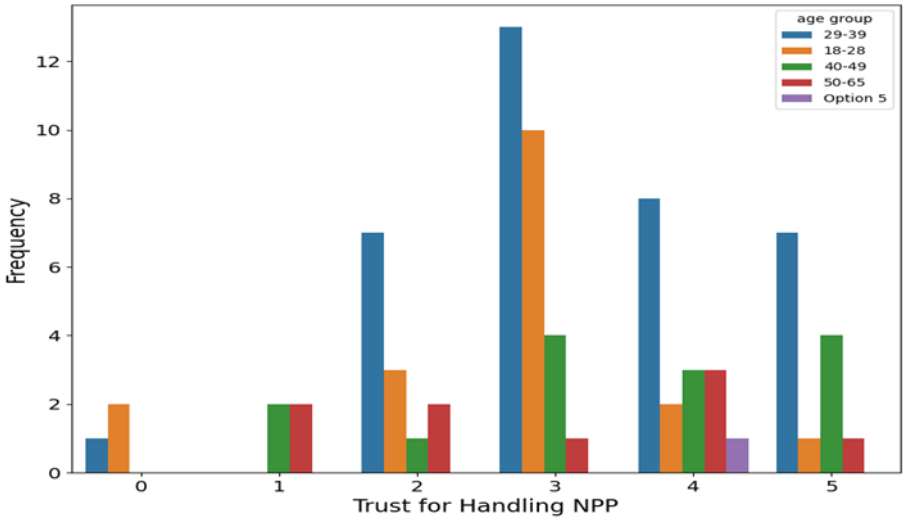


Figure 4. The trust for handling nuclear power plant based on age group.

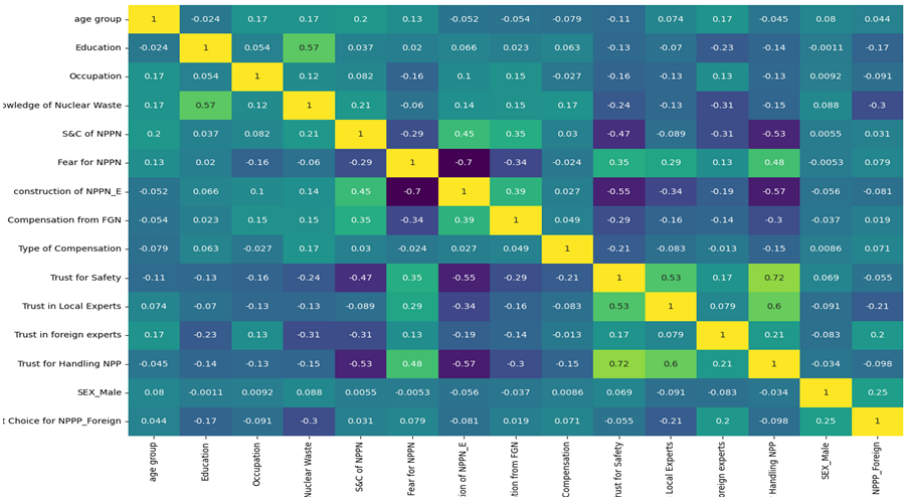


Figure 5. The Pearson correlation table for all the variables considered.

It is important to acknowledge the limitations related to the relatively narrow size of our study population (n = 78) and its homogeneity since it is made up mainly of well-educated professionals. Although this population comprises one segment of informed stakeholders, it is unlikely that theirs are representative opinions of the numerous Nigerians out there. Despite these limitations, findings of this study make important contributions to the attitudes of opinion leaders and technically informed citizens regarding selection and siting decisions on nuclear facilities, an area important

to early-stage policy making. The study examines socio-psychological determinants that impact acceptance by residents in the Southwest region of Nigeria of nuclear facilities. Findings yield several important conclusions that are divergent from traditional technical assessments. It is noted that general trust plays an important role in framing public opinion. In this context, local expertise takes on more importance than would usually be the case otherwise in other environments, particularly when compared to outcomes from developed nations whereby general institutional trust is more influential (Flynn et al., 1992; Kunreuther et al., 1990). The presence of such a tendency clearly signals an emerging local technical expertise in which there has been growing faith.

The complex interaction among support systems, education levels, and fear has important implications for the formation of public policy. Although previous work has mostly focused on perceived menaces in order to explain public resistance (Pijawka and Mushkatel, 1991), our findings show that perceptions are powerfully influenced by education levels. The strong correlation found between education and comprehension about nuclear waste in our population supports the conclusion that specifically designed education programs would be more effective if implemented by local professionals.

The differences in patterns of trust among the different age groups reflect an overall transformation that has to do with risk perception and acceptance of technology. Historical events and cultural shifts appear to impact people's attitudes toward nuclear technology differently; therefore, public communication efforts should take an age-focused approach.

The success of international facility projects yields lessons that can be translated into the Nigerian context. The Finnish Onkalo repository project is one notable illustration of this, exemplifying the model of fostering enduring public trust through continuous community involvement and transparency. Our findings regarding indigenous knowledge and the establishment of public trust are consistent with these overseas paradigms; however, they are informed by unique cultural and social imperatives particular to Nigeria. The strong emphasis on local knowledge in our findings suggests the need to create a "Nigerian model" for advancing nuclear facility development that allies national capabilities with international norms. In addition, the reverse correlation we found between decision-making participation and trust in facility operation has important implications regarding the structure of public participation processes and emphasizes the paramount value of combining technical proficiency with high-quality public participation.

6. Conclusion

This study investigated the socio-psychological factors driving the acceptance of nuclear infrastructure in Southwest Nigeria, with a special consideration of the dynamics of trust and the attitude of different populations. An analysis of 78 participants indicated that local experts' trust, education, and age significantly determine what people think of the application of nuclear technology. While the limitations placed on our comparatively small and professionally biased sample must be noted, the results remain important for what they reveal about how educated people perceive nuclear infrastructure development

in the context of Nigeria.

These findings have important implications for the formulation and implementation of policy in Nigeria. Foremost among these implications is the preference for indigenous expertise necessitating substantial investment in educational and training programs for indigenous nuclear technology. The public education policy should be overhauled such that it addresses educational stages and age groups with the aim of filling gaps between specialized technical knowledge and the public's knowledge. There should be explicit communication channels that explain the benefits and possible risks of nuclear technology, coupled with empirical fact-checking of public fears. The study outlines essential elements of institutional governance and regulatory frameworks. The local preference, coupled with the mandates of international security norms, suggests the necessity of a twofold approach to nuclear regulation. This should be viewed as a bid to build local regulatory capacity while promoting international cooperative relationships for the sharing of knowledge and coordination of security matters.

In looking ahead, there are a number of key areas that require attention in order to enable effective progress of nuclear facilities in Nigeria. These include wide-ranging education programs in regard to nuclear technology, security, and application; open, systematic, and continuous communication between the technical community and the public; institutionalized participatory mechanisms within which there is public involvement that enables public influence without compromising on the technical soundness of decision-making; local technical capacity building by tailored training programs and collaborations with the international community; and public participation that adjusts for cultural and generational considerations such that local issues are judged in terms of international standards.

This research greatly improves the comparatively underdeveloped understanding of the complex relationships among the many factors that determine public acceptance of nuclear facilities in Nigeria. The findings of this research are expected to provide a stronger foundation for the making of policies and strategies for public participation as Nigeria advances towards the development of its nuclear technology. Furthermore, the research provides a model for further research and suggests practical recommendations for the socially responsible advancement of nuclear facilities that will redirect the country towards a sustainable energy economy.

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Informed consent statement: Informed consent was obtained from all subjects involved in the study.

Data availability statement: Data utilized in this study is unavailable due to ethical restriction.

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