SSR Journal of Engineering and Technology (SSRJET)
Homepage: https://ssrpublisher.com/ssrjet/
Volume 3, Issue 8, 2026 ISSN: 3049-0383
OPEN ACCESS

Solar Powered Water Purification System in Southeast Nigeria

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Received: *11.06.2026* | ***Accepted:*** *11.07.2026* | ***Published:*** *04.08.2026*

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DOI: *10.5281/zenodo.21786616*

Abstract **Original Research Article**

This study critically assessed the effectiveness and sustainability of solar powered Water Purification Systems in some selected communities of Anambra State, Southeast Nigeria. The study is inspired by the continuing water shortage problem, poor water quality conditions and poor electrical power supply in various communities in the region. Specifically, water quality before and after treatment using the solar powered water purification systems was analysed technically to determine the impact of the water purification systems on water quality and also to evaluate the socio economic and environmental factors that would influence the adoption and sustainability of the solar powered water purification systems. A quantitative cross sectional design was used which involved water quality analysis in the laboratory and survey methods in the household. Structured questionnaires were used to collect data from 150 households and 45 water samples were analysed for physicochemical and microbiological properties. Data were analyzed with descriptive statistics, paired sample t tests and multiple regression analysis at 0.05 level of significance. Results showed that water quality improved drastically after its purification by solar method in respect of turbidity, TDS, faecal coliform and the values reduced from 14.75 NTU to 2.16 NTU, 628.40 mg/L to 182.74 mg/L and 137.53 CFU/100 ml to 3.28 CFU/100 ml respectively ($p<0.05$). In addition, household income ($\beta = 0.381$), awareness ($\beta = 0.413$) and technical support ($\beta = 0.289$) significantly increased system sustainability, while maintenance cost ($\beta = -0.265$) negatively impacted system adoption. The study findings showed that solar powered water purification systems are a feasible and sustainable solution to enhance access to potable water in the catchment area of Southeast Nigeria.

Keywords: Solar powered water purification, potable water, renewable energy, Southeast Nigeria.

Introduction

Safe and affordable drinking water is a basic need in developing countries for sustainable development, public health enhancement and socio-economic transformation. However, lack of adequate treatment infrastructure, high population growth, environmental degradation and energy shortage continues to necessitate the use of unsafe water sources by millions of people in Sub Saharan Africa (Fagorite et al., 2022; Abubakar, 2021; Okuyade et al., 2024). In Nigeria, long-standing weaknesses in public water systems have fueled the reliance on sources of water that lack treatment such as rivers, streams and harvested rainwater, especially in rural and peri urban areas where water infrastructure is weak or non-functional (Abubakar, 2021; Gbaarabe & Sodiki, 2022; Nnaji et al., 2024). This dependence has increased the risk of people being exposed to waterborne diseases and other health hazards caused by microbial and chemical contamination (Agbasi et al., 2023; Fagorite et al., 2022; Azamzam et al., 2021). In Southeast Nigeria, the problem is particularly severe due to the combined impact of rapid urbanisation, industrial growth, poor waste management practices, agricultural operations, and the fluctuations of climatic conditions, on water quality (Agbasi et al., 2023; Nnaji et al., 2024; Okuyade et al., 2024). Many water resources have been reported with high levels of pathogens, heavy metals, suspended solids and other contaminants that often exceed recommended levels for potable water within the region (Agbasi et al., 2023; Fagorite et al., 2022; Abubakar, 2021). The conventional water purification methods have been unable to overcome these challenges, as they require electricity, advanced infrastructure, and high maintenance expenses, which are often not available in many communities in Nigeria (Gbaarabe & Sodiki, 2022; Adebisi et al., 2023; Okuyade et al., 2024). There is thus a growing interest in decentralized and renewable energy based water treatment systems that are able to work in resource constrained environments. Solar powered water purification systems have become more of a viable solution, as they not only utilize renewable energy but also serve the purpose of water purification, which helps to mitigate both energy and water insecurity (Ukoba et al., 2024; Fagorite et al., 2022; Maruf et al., 2024). The technologies like solar stills, PV powered filtration systems and solar disinfection units have proven to be very effective in microbial removal, turbidity reduction, overall water quality enhancement, with significantly reduced operational costs and environmental impacts (Obot et al., 2022; Egware et al., 2025; Adio et al., 2020). Moreover, the solar energy potential is high in Southeast Nigeria, and solar energy is increasingly being used in rural households, indicating favourable conditions for implementing solar based water purification systems (Anugwom et al., 2020; Obodoh et al., 2024; Ukoba et al., 2024). However, there are several technical shortcomings in terms of effectiveness and sustainability of solar powered water purification systems in the local context of Southeast Nigeria (Adebisi et al., 2023; Okuyade et al., 2024; Fagorite et al., 2022). Most studies have focused on design optimisation, laboratory testing and evaluations, while few are empirical in nature, focusing on the assessment of water quality improvement and socio-economic sustainability in regional context (Obot et al., 2022; Egware et al., 2025; Yusof et al., 2022). This disparity requires additional research. Thus, the present study used a critical approach to analyse the effectiveness and sustainability of solar powered water purification systems in some selected communities of Southeast Nigeria, Anambra State, with an aim to establish the water purification systems as effective and sustainable potable water source.

Objectives of the Study

1. To evaluate the technical effectiveness of solar powered water purification systems in improving potable water quality in selected communities in Anambra State.
2. To assess the socio economic and environmental determinants influencing the adoption and sustainability of solar powered water purification systems in selected communities in Anambra State.

Research Question

1. How effective and sustainable are solar powered water purification systems as a potable water solution in selected communities in Anambra State, Southeast Nigeria?

2. Literature Review

2.1 Conceptual Review

Solar Powered Water Purification Systems

Solar powered water purification systems are defined as water purification devices that are mainly powered by solar energy, which removes physical, chemical and biological contaminants from water for domestic, agricultural or industrial use (Fagorite et al., 2022; Okuyade et al., 2024). The growing popularity of these systems is due to the growing concern on global water crisis, high cost of energy, sustainability problems and demand for potable water in off-grid and energy constrained systems (Yusof et al., 2022; Ukoba et al., 2024; Adebisi et al., 2023). The solar powered water treatment technologies are those that harness solar radiation (renewable energy) by either thermal or photovoltaic means to drive water treatment processes, as opposed to conventional water treatment systems that rely heavily on fossil fuel based electric power. (Maruf et al., 2024; Akrim et al., 2024; Obodoh et al., 2024). Solar powered purification technologies comprise a wide variety of systems such as solar stills, solar disinfection systems, photovoltaic powered membrane filtration units and hybrid solar desalination systems (Obot et al., 2022; Egware et al., 2025; Azamzam et al., 2021).

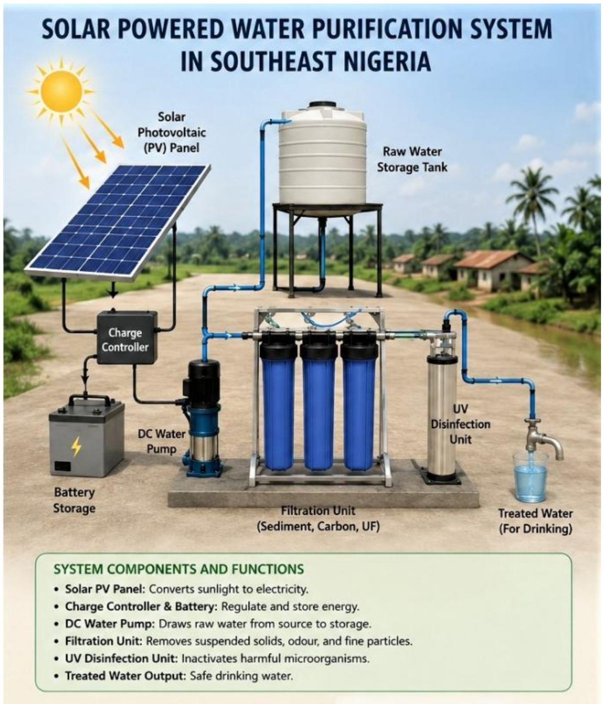

Figure 1: Schematic Diagram of the Solar Powered Water Purification System

Solar still technology is based on the principle of evaporation and condensation which involves the evaporation of the contaminated water from the solar still and its subsequent condensation in the purified water chamber (Obot et al., 2022; Adio et al., 2020). Solar disinfection systems, on the other hand, use the ultraviolet radiation and the heat effects on water to inactivate pathogenic microorganisms in water (Azamzam et al., 2021). Pumps, filters, and complex treatment methods like reverse osmosis and ultraviolet sterilisation are powered by PV based systems which convert sunlight into electricity, thereby reducing reliance on electricity from the grid (Maruf et al., 2024; Akrim et al., 2024). Solar powered purification systems have been suggested to have numerous benefits over traditional treatment technologies, including the ability to avoid reliance on grid electricity, to lower operational expenses, to decrease the emissions of greenhouse gases, and to allow for decentralized water supply in remote regions (Fagorite et al., 2022; Okuyade et al., 2024; Ukoba et al., 2024). The performance of these systems is, however, influenced by the intensity of the solar radiation, climatic conditions, efficient design of the system, maintenance of the systems and user acceptance (Yusof et al., 2022; Egware et al., 2025; Adebisi et al., 2023). Moreover, sustainability of solar powered water purification cannot be assessed only in terms of technology but also needs social, economic and environmental aspects.

Technical Effectiveness of Solar Powered Water Purification Systems

The efficiency or effectiveness of the purification system in removing or lowering the levels of contaminants to the acceptable limits for drinking water standards is technical effectiveness (Adio et al. 2020; Azamzam et al. 2021). With regards to solar powered systems, efficiency is generally measured in terms of microbial removal efficiency, turbidity reduction, dissolved solids removal, heavy metal removal and overall compliance with national and international potable water standards and guidelines (Obot et al., 2022; Fagorite et al., 2022; Egware et al., 2025). So far, there is some evidence that solar based purification technologies are very effective in reducing microbial contamination and physicochemical parameters of water (Adio et al., 2020; Azamzam et al., 2021; Yusof et al., 2022). However, significant differences in performance have been noted among various environmental conditions and this is attributed to the influence of various factors on treatment efficiency, including cloud cover, ambient temperature, feed water quality, and system configuration (Obot et al., 2022; Adebisi et al., 2023; Egware et al., 2025). Solar radiation and water quality characteristics in tropical regions like Southeast Nigeria could vary by season, impacting system productivity and treatment results, thus requiring context specific assessment (Agbasi et al., 2023; Okuyade et al., 2024; Fagorite et al., 2022).

Sustainability and Adoption Determinants

Sustainability in solar powered water purification goes beyond just the performance of the technology; it involves the ability of communities to accept, maintain and keep using such technology over time (Anugwom et al., 2020; Ukoba et al., 2024; Abubakar, 2021). Several socio economic variables have been proven to significantly affect the decisions that are made concerning adoption, these variables include household income, level of education, awareness, perceived practicality, affordability, technical support, etc. (Abubakar, 2021; Anugwom et al., 2020; Ukoba et al., 2024). Long term system sustainability is also influenced by environmental factors such as availability of solar resource, climatic variability, and characteristics of the local water sources (Yusof et al., 2022; Agbasi et al., 2023; Okuyade et al., 2024). However, there have been concerns that many renewable energy projects in developing nations have been poorly executed due to their technical approach and lack of understanding of the local social and institutional context (Anugwom et al., 2020; Ukoba et al., 2024; Obodoh et al., 2024). Thus, modern research increasingly suggests the use of integrated methods that look at technological efficiency, cost-effectiveness, community engagement, and institutional support to improve the sustainability outcomes (Maruf et al., 2024; Akrim et al., 2024; Okuyade et al., 2024).

2.2 Theoretical Review

This study was anchored on the Technology Acceptance Model and the Sustainable Livelihood Theory.

Technology Acceptance Model

In 1989, Datia Davis proposed the Technology Acceptance Model (TAM), which was designed to account for factors that could affect an individual's acceptance and use of new technologies. The theory suggests that perceived usefulness and perceived ease of use are two key factors that influence users' attitudes towards technology adoption, which in turn affects their behavioural intention and actual usage (Anugwom et al., 2020; Ukoba et al., 2024). Relevance of the Technology Acceptance Model to Solar-Powered Water Purification is that it is able to explain the willingness of the household to adopt and continue using solar based systems for water purification. The community is likely to be more accepting of solar purification technologies if they believe that the technology is effective, affordable, reliable, and easy to use (Anugwom et al., 2020; Abubakar, 2021; Maruf et al., 2024). On the other hand, an apprehension of high costs, maintenance complexity, or uncertain performance can prevent adoption (Ukoba et al., 2024; Obodoh et al., 2024; Adebisi et al., 2023). Yet, critics have contended that the TAM is a weak model to explain technology acceptance in developing nations because it fails to consider contextual factors like environmental constraints, cultural norms, and institutional arrangements that often influence technology adoption (Anugwom et al., 2020; Ukoba et al., 2024). Despite these restrictions, the model is still helpful in explaining the socio-economic factors that can affect the sustainability of solar powered water purification systems.

Sustainable Livelihood Theory

Sustainable Livelihood Theory grew out of Chambers and Conway's work and focuses on the ability of households/communities to acquire and retain assets they require to survive, amid shocks and stresses from the outside. The theory acknowledges that sustainability of livelihood is connected with human, social, financial, physical and natural capital resources (Abubakar, 2021; Gbaarabe & Sodiki, 2022). In the context of Solar-Powered Water Purification, Sustainable Livelihood Theory offers a comprehensive framework for comprehending the role of access to water and renewable energy technologies in enhancing health, decreasing vulnerability, increasing productivity, and promoting environmental sustainability (Okuyade et al., 2024; Fagorite et al., 2022; Gbaarabe & Sodiki, 2022). The theory also posits that the sustainability of such interventions is largely influenced by financial resources, technical knowledge, institutional support, and environmental conditions (Abubakar, 2021; Ukoba et al., 2024; Obodoh et al., 2024). However, the theory has been criticized for its general conceptual approach and lack of specificity in predicting particular behavioural responses to technology uptake (Anugwom et al., 2020; Ukoba et al., 2024). However, it is also criticized due to its holistic approach, which makes it especially applicable to the analysis of the technical, social and environmental aspects of solar powered water purification systems.

2.3 Empirical Review

Obot et al. (2022) studied the efficiency of a solar still that was combined with a charcoal and gravel basin to purify brackish water in Nigeria. The authors reported large water quality improvements and considerable reductions of contaminants from experimental analysis. The study proved the technical feasibility of the low cost solar distillation technologies. The investigation was however, limited to engineering performance and not involved in the community uptake and long-term sustainability issues. Adio et al. (2020) investigated the performance of solar distillation of impure water collected from four various sources in Southwestern Nigeria climatic condition. Solar distillation results showed significant decrease in turbidity, total dissolved solids and microbial contamination. While the study proved effective in treating samples under tropical setting in Southwestern Nigeria, its geographical scope is restricted to the tropical condition of Southwestern Nigeria and cannot be directly applied to Southeast Nigeria where the socio environmental condition is different from the Southwestern region of Nigeria (Adio et al., 2020; Agbasi et al., 2023). Egware et al. (2025) developed and constructed a thermal solar water purification system and measured high purification efficiencies with the experimental tests. The study concluded that solar still technology can be considered as cost effective and environmentally friendly process for potable water production. But the research was mainly focused on the system making and performance testing without considering the user perception or operational sustainability in real communities. A detailed review of solar energy applications in water treatment was performed by Fagorite et al. (2022) from a global and African perspective. According to their analysis, solar technologies have a significant potential to help solve water scarcity problems in Africa. However, the authors found that there are still challenges that persist such as insufficient investment, technical constraints, lack of maintenance culture and institutional support. The study was review based and empirical evidence from the local communities was limited. In total, the reviewed research confirmed the potential of using solar-powered systems for water purification and identified socio-economic aspects as key factors influencing the sustainability of the systems (Obot et al., 2022; Egware et al., 2025; Fagorite et al., 2022). But the existing literature was still sparse due to the fact that engineering studies did not consider the social sustainability aspects of technology while adoption studies focused mainly on water quality rather than water quality outcomes (Anugwom et al., 2020; Okuyade et al., 2024; Adebisi et al., 2023). Moreover, no empirical study has been carried out to analyse both the technical effectiveness and sustainability factors of solar powered water purification systems in Southeast Nigeria at the same time. This study focused on this very important gap to incorporate both dimensions in the frame of selected communities of Anambra State.

Materials and Methods

The study was of quantitative nature to critically assess the effectiveness and sustainability of solar powered water purification system (WPWS) in selected rural and peri urban communities in Anambra State, Southeast, Nigeria. The selection of Anambra State was justified by the persistent problems associated with potable water accessibility, growing solar energy technologies usage and presence of high level of solar radiation that would be appropriate for solar based water treatment application (Anugwom et al., 2020; Agbasi et al., 2023; Obodoh et al., 2024). A cross sectional survey design was used since it allowed the technical performance of the solar powered purification systems and the socio economic and environmental factors that influence the sustainability of the systems to be examined at the same time (Adebisi et al., 2023; Okuyade et al., 2024; Maruf et al., 2024). Three communities (Awka, Nnewi and Onitsha) were selected purposively because of their different socio economic features and access to potable water infrastructure. In total, 150 households that are currently using solar powered water purification systems were selected using stratified random sampling. Primary data was collected through structured questionnaires, which were used to draw information from the household heads regarding their perception of the drivers of adoption, affordability, satisfaction, maintenance practices and perception of sustainability. Furthermore, samples of the untreated water and the water purified by Solar Water Treatment System was taken from the selected communities for laboratory analysis (Abubakar, 2021; Anugwom et al., 2020, Okuyade et al., 2024). Standard methods recommended by World Health Organization (WHO) were used for the laboratory analysis of key potable water quality indicators: pH, turbidity, total dissolved solids (TDS), faecal coliform count and heavy metals. Data were summarised using descriptive statistics (means, percentages and standard deviation) and significant differences among water quality parameters of untreated and treated water were determined by using paired sample t test. Multiple regression analysis was also used to investigate the effect of the socio-economic and environmental variables on the sustainability of the systems at 0.05 level of significance. These analytical procedures were deemed suitable as they enabled a comprehensive analysis of the effectiveness of the technical and sustainability factors in the study area (Obot et al., 2022; Egware et al., 2025; Fagorite et al., 2022).

Results and Discussion

4.1 Technical Effectiveness of Solar Powered Water Purification Systems in Improving Potable Water Quality

Selected physicochemical and microbiological parameters of the untreated and treated water samples collected from selected study communities were analysed in order to evaluate the technical effectiveness of the purifying systems that are solar powered. The results are shown in Table 1.

Table 1: Comparison of Water Quality Parameters before and after Solar Purification (n = 45 Water Samples)

Water Quality Parameter	**Untreated Water Mean ± SD**	**Solar Treated Water Mean ± SD**	**WHO Standard**	**Mean Difference**	**t value**	**p value**
pH	5.84 ± 0.63	6.92 ± 0.41	6.5 to 8.5	1.08	8.64	0.000
Turbidity (NTU)	14.75 ± 3.12	2.16 ± 0.94	< 5 NTU	12.59	24.81	0.000
Total Dissolved Solids (mg/L)	628.40 ± 58.36	182.74 ± 30.28	< 500 mg/L	445.66	32.46	0.000
Faecal Coliform (CFU/100 ml)	137.53 ± 25.48	3.28 ± 1.36	0 CFU/100 ml	134.25	41.22	0.000
Lead Concentration (mg/L)	0.038 ± 0.011	0.009 ± 0.003	< 0.01 mg/L	0.029	11.93	0.000

Source: Field Survey and Laboratory Analysis, 2026.

Figure 2: Improvement in Water Quality After Solar Purification

Table 1 indicated that solar powered water purification systems have seen substantial improvement in all the measured parameters of water quality. Purification increased the mean pH from 5.84 to 6.92, thus making the water within the recommended acceptable range recommended by the World Health Organization. The turbidity reduced significantly from 14.75 NTU to 2.16 NTU, which is 85.4 % drop. Likewise, the total dissolved solids (TDS) concentration decreased from 628.40 mg/L to 182.74 mg/L after treatment. The results also showed very significant decreases in microbiological contamination. The mean faecal coliforms counts are 137.53 and 3.28 for untreated and solar purified samples respectively. The reductions in heavy metal concentration were also statistically significant at 5 percent significance level ($p < 0.05$) as revealed by the Paired sample t test results. Hence, the null hypothesis of the study that the solar powered water purification system was not able to significantly improve the quality of water was rejected.

4.2 Socio Economic and Environmental Determinants Influencing Adoption and Sustainability of Solar Powered Water Purification Systems

To identify socio-economic and environmental factors associated with the adoption and sustainability of solar powered water purification systems in households a multiple regression was performed. The results obtained are tabulated in Table 2.

Table 2: Multiple Regression Results for Determinants of Adoption and Sustainability of Solar Powered Water Purification Systems (n = 150)

Predictor Variables	**Unstandardised Coefficient (β)**	**Standard Error**	**t value**	**p value**
Constant	1.842	0.426	4.324	0.000
Household Income	0.381	0.087	4.379	0.000
Educational Level	0.294	0.081	3.630	0.001
Awareness of Solar Technology	0.413	0.076	5.434	0.000
Maintenance Cost	-0.265	0.069	-3.841	0.000
Solar Radiation Availability	0.336	0.074	4.541	0.000
Access to Technical Support	0.289	0.078	3.705	0.001

Model Summary: $R = 0.781$; $R^2 = 0.610$; Adjusted $R^2 = 0.592$; $F = 34.286$; $p = 0.000$.

Source: Field Survey, 2026.

The regression model was statistically significant as shown in Table 2 ($F = 34.286$; $p = 0.000$). The coefficient of determination (Adjusted $R^2 = 0.592$) suggested that the predictor variables in the model accounted for about 59.2 percent of the variations in the adoption and sustainability of solar powered water purification systems. The results indicated that household income ($\beta = 0.381$, $p < 0.05$), education ($\beta = 0.294$, $p < 0.05$), solar radiation availability ($\beta = 0.336$, $p < 0.05$) and availability of technical support ($\beta = 0.289$, $p < 0.05$) were all positive and significant in relation to adoption and sustainability. On the other hand, the sustainability was significantly negatively correlated with maintenance cost ($\beta = -0.265$, $p < 0.05$). Therefore, the null hypothesis that socio economic and environmental factors did not play a significant role in the adoption and sustainability was rejected.

Discussion

The results showed high technical impact of solar powered water purification systems in improving potable water quality in the selected communities. This marked a considerable decrease in turbidity, dissolved solids, microbial and heavy metal concentrations indicating that solar purification technologies may be an alternative to conventional water purification systems in developing countries with limited resources. This result was consistent with the results of Obot et al. (2022) which observed significant water quality improvement after using charcoal and gravel basin lined solar still. The results also corroborated the results of Adio et al. (2020) who reported substantial decrease in turbidity and total dissolved solids due to solar distillation under climatic condition in Nigeria. Likewise, the results of microbial reduction were in support of the results of Azamzam et al. (2021) who had previously concluded that solar disinfection technologies were effective in eliminating pathogenic microorganisms by thermal and ultraviolet mechanisms. The results also corroborated with the results of Egware et al. (2025) which indicated high purification efficiencies for the solar water purification systems with thermal drive. The present result, thus, supports the argument of Fagorite et al. (2022) and Okuyade et al. (2024) that the Renewable Energy (RE) driven purification systems can significantly improve water security in off grid and underserved communities.

The findings also indicated that socio economic and environmental factors play significant role in the sustainability of solar powered water purification system in Southeast Nigeria. Household income turned out to be an important factor, suggesting that solar purification systems were more easily obtained and operated by economically privileged households. This was similar to the conclusion by Abubakar (2021) that income has a significant effect on the water treatment behaviour of households in Nigeria. The finding further confirmed the finding of Anugwom et al., (2020) who found income to be one of the key determinants of adoption of solar technologies by the households in Southeast Nigeria. The important role of education and awareness also indicated that knowledge and understanding of renewable technologies improved adoption behaviour. This result is aligned with the views of Ukoba et al. (2024) who noted that technical literacy and awareness were still very important for the diffusion of renewable energy in the Global South. These findings align with the studies by Fagorite et al., (2022) and Adebisi et al. (2023), who found financial constraints and maintenance problems were significant challenges for sustainable implementation of solar water treatment technologies. Favorable environmental conditions and institutional support structures were also found to be vital for the long-term sustainability of renewable energy systems, in line with the findings of Okuyade et al. (2024) and Obodoh et al. (2024) which credited solar radiation availability to this. Overall, the study results showed that technical efficiency was not the only factor that determines sustainable adoption, the socio economic and environmental factor also had a significant influence in determining the adoption in the long term.

Conclusion and Implications

This study critically analysed the effectiveness and sustainability of the solar powered water purification systems in some selected communities of Anambra State, southeast Nigeria. The results confirmed that the solar purifiers were quite effective in improving the quality of potable water that was obtained from the water samples by reducing the concentration of turbidity, total dissolved solids, faecal coliform, and heavy metals, which met most of the drinking water recommendations. The statistical analysis proved to be statistically significant between the water sample collected before and after treatment and hence it has been established that the purification technologies using solar energy are technically feasible as sustainable solutions for purification of water in developing countries lacking the basic infrastructure. The results confirmed previous discussions about the potential of renewable energy powered water treatment technologies to solve chronic potable water problems in communities with little or no access to water treatment facilities (Obot et al., 2022; Adio et al., 2020; Egware et al., 2025). The study also demonstrated that technology efficiency was not the only factor determining the long term sustainability of solar powered water purification systems. Household income, level of education, knowledge about solar technologies, availability of solar radiation and access to technical support were significant factors that improved adoption and sustainability, while high maintenance costs limited continuous use. This discovery indicated the need for an integrated approach that covers technological, socio-economic and institutional aspects for successful deployment of solar powered purification systems (Anugwom et al., 2020; Ukoba et al., 2024; Okuyade et al., 2024). The study thus proposed to sink the traditional engineering view of water purification as a technical issue and rather suggest that the access to water, in terms of sustainability in Southeast Nigeria is mainly influenced by the bigger picture in the region. The implications of these findings are tremendous. Policy level, decentralized solar powered water purification systems should be prioritized by government agencies and development partners with reference to rural and peri urban communities who do not have access to conventional water supply systems and grid electricity. Moreover, there is a need for targeted public awareness programme, financial mechanisms and technical capacity building to improve community take up and sustainability of the system over time (Fagorite et al., 2022; Abubakar, 2021; Maruf et al., 2024). In practice, the study has shown that the integration of RE technologies in water service delivery can also help to achieve public health, environmental sustainability and sustainable development goals in Southeast Nigeria.

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