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Adoption of Photovoltaic Systems and Its Social, Economic and Environmental Impacts on the Community in Taita Taveta County, Kenya

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ABSTRACT: Purpose of the study: The study examined the adoption of photovoltaic systems and its social, economic and environmental impacts in Taita Taveta County.
Problem statement: Although Kenya lies within the tropical zone and receives abundant solar radiation throughout the year, the uptake of solar technology remains low among rural populations due to high installation costs, limited financing, and inadequate awareness. In Taita Taveta County, where solar irradiance averages 4–6 kWh/m², many households remain off-grid and depend on non-renewable sources like kerosene and firewood, resulting in persistent energy poverty, health risks, and environmental degradation.
Methodology: A descriptive research design was adopted, targeting four sub-counties i.e. Voi, Taveta, Mwatate, and Wundanyi. The study population comprised 97,334 households, with 23.8% (23,165 households) identified as off-grid. A sample of 279 households was determined using Cochran's formula. Stratified random sampling was then applied to ensure representation of rural off-grid households from the four sub-counties in Taita Taveta County as follows; Voi (91), Taveta (75), Mwatate (67), and Wundanyi (46). The study employed a multiple linear regression model.
Results of the study: The findings showed that slightly more than half of the households surveyed had adopted PV systems, demonstrating a growing but not yet universal shift towards solar energy. Correlation analysis revealed that while adoption challenges had an inverse relationship with PV uptake, the social, economic, environmental, and sustainability dimensions were positively correlated with adoption success. Regression analysis showed that adoption challenges exhibited a significant negative effect, indicating that greater barriers to adoption hinder PV uptake.
Conclusion and policy: Despite existing challenges, over half of the households had adopted PV systems, showing rising acceptance and notable socio-economic and environmental benefits. These insights can guide policymakers in designing incentives and financing models to enhance PV adoption.s
Recommendations: The study recommended government partnerships to enhance subsidies, affordable financing, and technical support, while integrating PV adoption into rural development and county energy plans.

KEYWORDS: Photovoltaics, renewable energy, sustainability, solar, Green Energy Transition, Solar irradiance, Taita Taveta.

INTRODUCTION

Despite Kenya's geographical advantage of abundant sunlight in the tropics, the high cost of solar technology hinders widespread adoption among the rural populations, who are often economically disadvantaged (Kiplagat et al, 2021). The low adoption rate is largely due to barriers such as; lack of awareness, regulatory policies that discourage private investment in solar energy, insufficient financing, and poor infrastructure etc. (CIDP, 2018). The promise of clean, sustainable, and reliable energy remains out of reach for many leading to severe consequences. Rural households allocate much of their income on non-renewable energy sources, posing health risks and reducing individual's disposable income (Odhengo et al, 2019).

Energy shortage undermines education, healthcare systems, and business operations, critical for the country's economic growth and development (Odhengo et al, 2019). To address the abovementioned challenges, the government needs to subsidize solar equipment, and incentivize local manufacturing of photovoltaic components to reduce costs, establish regulatory policies that encourage private investment in solar energy infrastructure as well as public awareness campaigns to drive demand and innovations toward solar energy.

The adoption of photovoltaic (PV) systems in Kenya has attracted growing attention for its potential to foster sustainable development through improved access to clean energy. Although limited studies have focused on Taita Taveta County, existing literature across Kenya provides relevant insights into the opportunities and barriers influencing PV adoption. Karakaya et al. (2015) identified high initial costs and weak implementation of energy policies as major obstacles to rural solar adoption, emphasizing the need for stronger institutional and infrastructural support. Similarly, Nyangaresi (2024) examined financial constraints in Kisii County and proposed flexible financing mechanisms such as pay-as-you-go and micro-credit models to enhance access. However, broader economic and investment-related challenges, including inadequate incentives and infrastructure deficits remain underexplored.

Social and behavioral factors have also emerged as critical determinants of solar energy adoption. Vasi et al. (2023) found that community engagement, social trust, and peer influence significantly affect PV uptake, though their study was limited to urban contexts. In Kenya, Wambui (2024) observed that PV electrification in Kitui County improved education outcomes and income-generating opportunities, yet failed to assess environmental benefits. Likewise, Al Rawi et al. (2023) reported that PV adoption improved healthcare delivery in rural settings by ensuring reliable electricity but overlooked its broader social implications, such as improved security and quality of life. These findings underscore that PV adoption is not solely an economic or technological issue but also a social process influenced by awareness, trust, and community participation.

The theories presented in this study established a very robust framework for understanding the relationship between the variables. The Diffusion of Innovations Theory highlighted the adoption of photovoltaic systems among households and business enterprises in the region, with notable factors including perceived benefits and social and environmental impacts. The Triple Bottom Line Theory underpinned the nexus between environmental, social, and economic dimensions in the adoption of photovoltaic system (Dainiene et al., (2015)). The Energy Access and Empowerment theory underscored how decentralized energy solutions, such as photovoltaic (PV) systems, play a pivotal role in breaking cycles of energy poverty while addressing environmental concerns. It also supported the adoption of photovoltaic (PV) systems as a sustainable energy solution that enhances economic stability and promotes social equity. These theories jointly, revealed how adopting these systems addresses socio-economic and environmental impacts, thereby promoting sustainable development in Taita Taveta County.

Globally, the adoption of renewable energy—particularly solar power—has gained significant momentum as part of efforts to mitigate climate change, reduce reliance on fossil fuels, and enhance energy access in developing regions. Countries worldwide are increasingly integrating solar energy into their energy mix due to its cost-effectiveness, scalability, and environmental benefits. The transition to green energy has further accelerated with falling photovoltaic (PV) costs, technological innovations, and global commitments under frameworks such as the Paris Agreement (IRENA, 2022). Solar power plays a key role in addressing energy poverty by supporting decentralized electrification and providing clean, reliable energy to rural communities, thereby reducing dependence on biomass and kerosene. Moreover, photovoltaic adoption fosters socio-economic development through job creation and growth in manufacturing, installation, and maintenance sectors (IRENA, 2020). These benefits underscore the central role of PV systems in mitigating climate change, promoting sustainable economic growth, and advancing Sustainable Development Goal 7 on affordable and clean energy (Abid et al., 2023).

For Kenya, green energy transition (GET) is crucial to achieving the country’s vision 2030 like solar, and wind energy, as well as the National Climate Change Action Plan (Ministry of Energy, 2022). In sub-Saharan Africa, Kenya is a leader in renewable energy, with potential investments in solar energy, geothermal energy, and wind energy. Government policies like tax exemptions on solar equipment aims to encourage the adoption of solar energy, however, off-grid areas remain underserved due to barriers such as high installation and maintenance costs, limited public awareness, and financial constraints (Ulsrud et al, (2022)).

In Taita Taveta County, many households use photovoltaic energy systems mainly for lighting (CIDP, 2018). This proves over-reliance on carbon emitting and costly energy sources like kerosene, firewood etc. This study was conducted in Taita Taveta County, encompassing all its four sub-counties i.e. Voi, Mwatate, Taita and Wundanyi, with majority of its population off-grid thus heavily depend on non-renewable energy sources. This presented a space to assess the adoption of photovoltaic systems.

The study examines Photovoltaic (PV) Adoption Success as the main outcome, influenced by adoption challenges, social impacts, economic impacts, environmental impacts, and sustainability factors. These variables are interlinked such that; reducing adoption challenges enhances social awareness, economic empowerment, and environmental conservation, which together strengthen sustainability and improve overall PV adoption success. This relationship highlights how overcoming financial, infrastructural, and policy barriers can yield broad socio-economic and environmental benefits, addressing the research gap on PV adoption in off-grid communities of Taita Taveta County.

Statement of the Problem

The promise of clean, sustainable, and reliable energy remains out of reach for many despite Taita Taveta County’s abundant solar irradiance of 4-6 kWh/m² (CIDP, 2018). These barriers have severe consequences like; energy poverty, environmental degradation and inadequate socio-economic opportunities. Rural households spend much of their earnings to non-renewable energy sources, reducing their disposable income and exposing them to health risks (Ulsrud et al, (2022)). Further, renewable energy scarcity undermines education, healthcare systems as well as business operations, which are critical for economic growth and development (Ulsrud et al, (2022); CIDP, 2018).

Previous studies in Kenya have managed to explore renewable energy adoption but their focus has been on limited variables and contexts. For example; Njoroge and Wambua (2022) researched on solar energy adoption and its impacts on rural household energy savings. Wallace et al., (2020) studied the role of photovoltaic (PV) systems in enhancing economic productivity in off-grid communities in Kenya. These aforementioned studies clearly highlighted socio-economic benefits but failed to comprehensively address the barriers to the adoption of photovoltaic systems as well as environmental impacts in the context of Taita Taveta County. This study aimed to bridge this contextual gap by focusing on the social, economic and environmental impacts of photovoltaic systems adoption in off-grid communities of Taita Taveta County.

Existing research has not deeply explored the link between photovoltaic systems and socio-economic impacts in areas like; education, healthcare, and business. Wanjohi and Mwangi (2021) majored on household energy usage, but did not explore the environmental dynamics which are driven by the adoption of solar energy. This research addressed this gap by assessing the relationship between photovoltaic systems and existing environmental impacts as well as its socio-economic impacts in education, healthcare and business.

Other studies on the adoption of renewable energy in Kenya such as those by Mwangi and Wambua (2021), have predominantly employed qualitative methods in assessing the impact of solar energy adoption on energy access, while quantitative research that statistically explores the socioeconomic and environmental impacts as a result of solar energy adoption are limited. This study filled this gap by employing quantitative research methods in providing a more comprehensive understanding of the barriers, benefits, as well as socioeconomic and environmental impacts of photovoltaic systems adoption. This provided greater insights into the opportunities and challenges for their adoption in Taita Taveta County.

Research Objectives

To examine the adoption of photovoltaic systems and assess their social, economic and environmental impacts on off-grid communities.

Research Hypothesis

H_{01}: There is no statistically significant relationship between the adoption of photovoltaic systems and the social, economic, and environmental outcomes in off-grid communities.

THEORETICAL FRAMEWORK

The Diffusion of Innovations Theory, developed by Rogers (1962), explained how new technologies spread within a society based on five key attributes. In the context of photovoltaic (PV) systems, their relative advantage which includes not only cost savings and energy independence but also significant environmental benefits such as reduced carbon emissions and lower fossil fuel dependence render them attractive to early adopters (Abid et al., (2023)). Compatibility with rural electrification needs and modern energy demands further accelerates adoption, while pilot projects and subsidies improve trialability. Observability, normally demonstrated through visible installations and documented environmental improvements, plays a crucial role in influencing broader community uptake (Abid et al., (2023)). The theory typically assumes that adoption follows a linear process driven by individual choices, often overlooking structural barriers such as policy constraints, financing difficulties, infrastructural deficiencies, and environmental externalities. It also underestimates the role of government and institutional actors in shaping adoption through environmental regulations, subsidies, and long-term strategic planning (Mugambi, J. K. (2021)).

The Triple Bottom Line (TBL) Theory, introduced by John Elkington (1994), expanded the traditional focus on profit to include social and environmental dimensions commonly referred to as People, Planet, and Profit. The TBL framework to PV system adoption revealed significant contributions across all three dimensions. Economically, research by Mwangi, Mutua, and Otieno (2022) demonstrates that PV systems can reduce energy costs and stimulate local economies by generating employment in the renewable energy sector. Rose et al., (2016) report that PV systems contribute to lowering greenhouse gas emissions and reducing dependence on fossil fuels. Studies by Stojanovskiet al., (2021). indicated that PV systems improve quality of life by providing reliable energy for households, schools, and healthcare facilities, thereby promoting broader social inclusion and improved public services. Dainiene et al., (2015) highlighted the difficulty in accurately measuring and balancing the three dimensions, as improvements in one area may result in trade-offs in another.

The Energy Access and Empowerment Theory emphasized the profound link between energy availability and broader societal transformation. In ensuring access to reliable energy sources such as electricity, communities can experience enhanced economic productivity, improved healthcare, and better educational opportunities. Sustainable energy solutions can also mitigate environmental degradation by reducing reliance on traditional biomass fuels, which contribute to deforestation and air pollution (Dube, 1997). The theory underscored how decentralized energy solutions, such as photovoltaic (PV) systems, play a pivotal role in breaking cycles of energy poverty while addressing environmental concerns. It assumes that simply providing energy solutions will lead to environmental benefits without fully addressing systemic barriers such as affordability, policy constraints, and infrastructural challenges

EMPIRICAL REVIEW

The adoption of photovoltaic (PV) systems in Kenya has attracted growing attention for its potential to foster sustainable development through improved access to clean energy. Although limited studies have focused on Taita Taveta County, existing literature across Kenya provides relevant insights into the opportunities and barriers influencing PV adoption. Karakaya et al. (2015) identified high initial costs and weak implementation of energy policies as major obstacles to rural solar adoption, emphasizing the need for stronger institutional and infrastructural support. Similarly, Nyangaresi (2024) examined financial constraints in Kisii County and proposed flexible financing mechanisms such as pay-as-you-go and micro-credit models to enhance access. However, broader economic and investment-related challenges including inadequate incentives and infrastructure deficits remain underexplored.

Social and behavioral factors have also emerged as critical determinants of solar energy adoption. Vasi et al. (2023) found that community engagement, social trust, and peer influence significantly affect PV uptake, though their study was limited to urban contexts. In Kenya, Wambui (2024) observed that PV electrification in Kitui County improved education outcomes and income-generating opportunities, yet failed to assess environmental benefits. Likewise, Al Rawi et al. (2023) reported that PV adoption improved healthcare delivery in rural settings by ensuring reliable electricity but overlooked its broader social implications, such as improved security and quality of life. These findings underscore that PV adoption is not solely an economic or technological issue but also a social process influenced by awareness, trust, and community participation.

Globally, studies further emphasize the role of policy frameworks and technological innovation in promoting solar energy adoption. Luthander et al. (2015) in Europe and Bauknecht et al. (2014) in Germany highlighted how policy incentives, energy storage integration, and net metering enhance solar system efficiency and uptake, though their analyses focused mainly on urban or grid-connected areas. In contrast, Boateng (2016) in South Africa demonstrated that solar home systems in rural areas lead to increased household income, improved education, and reduced reliance on kerosene, though environmental outcomes were not addressed.

CONCEPTUAL FRAMEWORK

The framework consisted of two main components: the PV adoption success (dependent variable), and the social, economic and environmental impacts (independent variables)

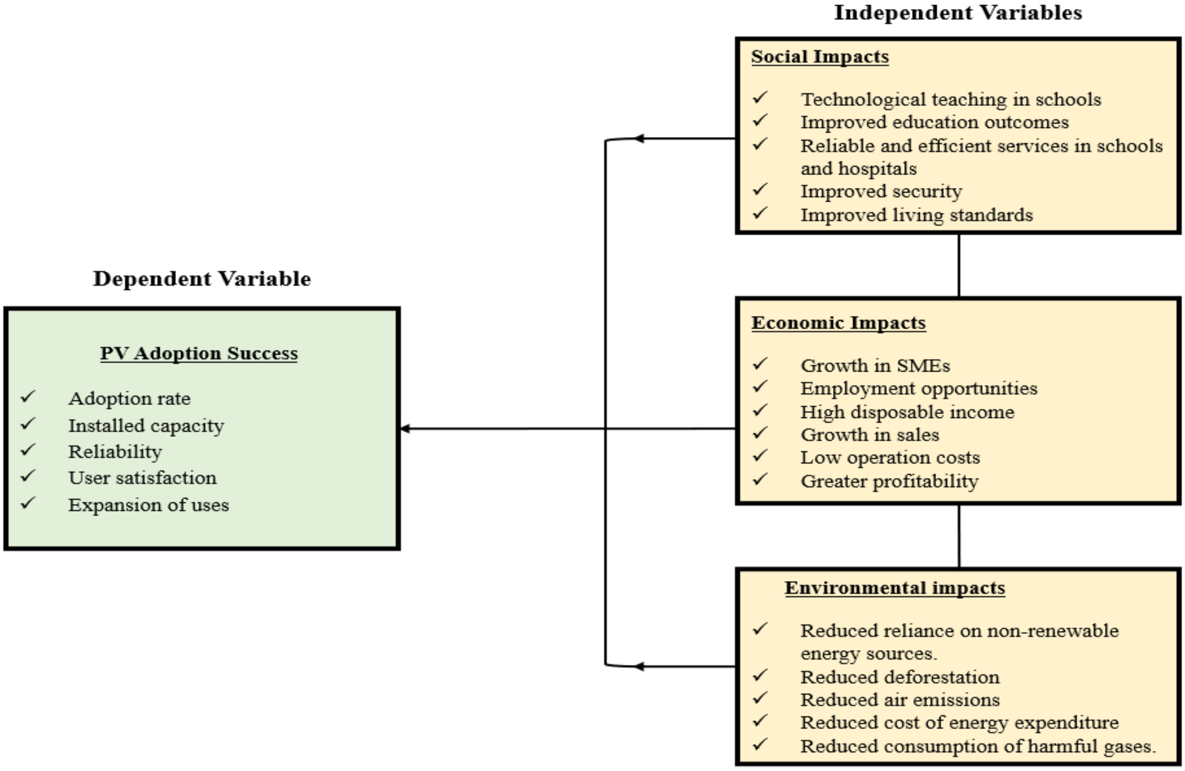

Figure 1: Conceptual Framework

RESEARCH METHODOLOGY

The study adopted a descriptive research design to assess the adoption of photovoltaic (PV) systems and their associated social, economic, and environmental impacts in Taita Taveta County. This design was appropriate as it enabled systematic collection and quantitative analysis of data to provide an accurate representation of existing conditions, relationships, and challenges surrounding PV system adoption (Mackey & Gass, 2015). The target population comprised 23,166 off-grid households drawn from the four sub-counties of Voi, Taveta, Wundanyi, and Mwatate. A sample of 279 respondents was determined using the Cochran (1977) formula and proportionately allocated across sub-counties to ensure representativeness. Stratified random sampling was used to capture variations across geographic areas, while primary data were collected through structured questionnaires featuring both closed and Likert-scale items to measure adoption challenges and the resulting social, economic, and environmental outcomes. The drop-and-pick method was used to administer the questionnaires, supported by oral administration in cases of limited literacy to enhance inclusivity and data reliability. Data were analyzed using IBM SPSS Statistics Version 22 to generate descriptive and inferential statistics, enabling the study to establish meaningful patterns and relationships among the key variables.

RESULTS AND DISCUSSIONS

This chapter presents the results and discussions of the reliability tests, descriptive statistics, correlation analysis, regression analyses, and ANOVA test to explain how adoption challenges, social, economic, environmental, and sustainability factors influence PV adoption success. The analysis is based on data obtained from 279 valid questionnaires issued to respondents across Taita Taveta County.

Reliability Test

A pilot study was conducted with 30 participants to test the reliability and internal consistency of the data.

Table 1: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items
.808	.794

The reliability test results in the table above show that the research instrument achieved a Cronbach's Alpha of 0.808, which falls within the "good" reliability range (≥0.8), indicating strong internal consistency. The instrument was therefore considered reliable and consistent.

Descriptive Statistics

The descriptive statistics provide a summary of the key variables analyzed in this study, including PV adoption success, adoption challenges, social, economic, environmental, and sustainability impacts. These statistics help to describe the general trends, variability, and distribution of responses collected from the 279 participants. The mean and standard deviation values offer insights into the central tendency and consistency of responses, forming the foundation for subsequent correlation and regression analyses.

Table 1: Descriptives Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PV Adoption Success	279	1.00	2.00	1.4695	.49997
Adoption Challenges	279	1.1667	4.5000	3.073477	.5820708
Social Impacts	279	2.1429	4.7143	3.505376	.4487666
Economic Impacts	279	3.1429	4.8571	3.986687	.3121831
Environmental Impacts	279	3.1667	4.6667	3.977897	.3242301
Impacts on Sustainable Energy Practices	279	1.3333	4.3333	3.051971	.5574392
Valid N (listwise)	279				

The descriptive results indicated that the mean score for adoption of PV systems was 1.4695 (SD = 0.4999), indicating that most respondents had adopted solar technology. On the other hand, adoption challenges recorded a mean of 3.073 (SD = 0.5821), suggesting that respondents moderately experienced barriers such as high installation costs, limited financing, and technical constraints. This showed that while adoption levels were fairly high, challenges still played a critical role in slowing down wider uptake. The results showed that respondents strongly agreed on the economic (M = 3.987, SD = 0.3122) and environmental (M = 3.978, SD = 0.3242) benefits of PV systems. The social impacts (M = 3.505, SD = 0.4488) and impacts on sustainable energy practices (M = 3.052, SD = 0.5574) highlighting that PV adoption has substantially reduced energy costs and environmental strain, while moderately improving social welfare and sustainability practices.

Pearson Correlation Analysis

The correlation analysis directly supports the general objective of examining the adoption of PV systems and its impacts on off-grid communities. It helped to examine if there was correlation between the dependent and independent variables.

Table 2: Correlation matrix

Variables	PV Adoption Success	Adoption Challenges	Social Impacts	Economic Impacts	Environmental Impacts	Impacts on Sustainable Energy Practices
PV Adoption Success	1					
Adoption Challenges	-.521*	1				
Social Impacts	.498*	.774*	1			
Economic Impacts	.546*	.783*	.762*	1		
Environmental Impacts	.472*	.602*	.638*	.661*	1	
Impacts on Sustainable Energy Practices	.438*	.569*	.552*	.601*	.482*	1

*. Correlation is significant at the 0.05 level (2-tailed).

The results showed that PV adoption success was positively and significantly correlated with adoption challenges (r = .521), social impacts (r = .498), economic impacts (r = .546), environmental impacts (r = .472), and sustainable energy practices (r = .438). This implies that while challenges existed, PV adoption success was associated with notable impacts across social, economic, and environmental dimensions, fulfilling the broad aim of the study. The significant negative correlation between adoption challenges and PV adoption success (r = -.521) indicated that economic, infrastructural, and investment challenges reduced uptake of PV systems. These finding leads to the rejection of H_0 (i), confirming that such challenges significantly influence the PV adoption success in rural Taita Taveta County.

The significant correlations between PV adoption success and social (r = .498), economic (r = .546), and environmental impacts (r = .472) suggest that PV systems have meaningful positive impacts in these areas, thus rejecting H_0 (ii). Similarly, the significant correlation between PV adoption success and sustainable energy practices (r = .438) supports the rejection of H_0 (iii). This means PV adoption success effectively promotes sustainability, highlighting its role in achieving long-term energy security and resilience in off-grid rural communities. These are as shown in the correlation matrix above with all significant correlations flagged.

Regression Analysis

The regression results were summarized in the model summary, ANOVA table and regression coefficients to jointly demonstrate the significance of the study variables included in the regression model.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.89	0.79	0.786	0.231

The correlation coefficient (R = 0.89) demonstrates a very strong positive relationship between the predictors (adoption challenges, social, economic, environmental, and sustainability impacts) and PV adoption success. The R Square value (0.79) indicates that 79% of the variation in PV adoption success in Taita Taveta County is jointly explained by the independent variables which reflects the robustness of the model. The Adjusted R Square (0.786), confirmed that the model was not overfitted and that it was generalizable. The relatively small standard error of estimate (0.231) further shows that the predicted values aligned closely with the actual observed data.

Table 4: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.270	.314		4.046	.000	.654	1.886
	Adoption Challenges	-.182	.041	-.201	-4.439	.000	-.262	-.102
	Social Impacts	.214	.052	.189	4.115	.000	.112	.316
	Economic Impacts	.323	.064	.279	5.048	.000	.197	.449
	Environmental Impacts	.156	.058	.132	2.690	.008	.042	.270
	Impacts on Sustainable Energy Practices	.201	.047	.210	4.277	.000	.108	.294

Adoption challenges show a negative effect, with a coefficient of B = -0.182, standardized beta β = -0.201, t-value -4.439, and $p < 0.05$, indicating that higher barriers such as high installation costs, limited financing, and technical or infrastructural limitations reduce PV adoption success by 0.182 units for each unit increase in the adoption challenges. Social impacts are positively influenced by PV adoption success, with B = 0.214, β = 0.189, t = 4.115, and $p < 0.05$, meaning that each unit increase in PV adoption success improves social well-being by 0.214 units. Economic impacts have the strongest effect, with a coefficient of B = 0.323, standardized beta β = 0.279, t = 5.048, and $p < 0.05$, indicating that PV adoption success improves economic outcomes by 0.323 units for each unit increase in adoption. Environmental impacts are also positively affected, with B = 0.156, β = 0.132, t = 2.690, and $p < 0.05$, meaning that PV adoption success contributes to environmental conservation. Impacts on sustainable energy practices are strengthened with a coefficient of B = 0.201, standardized beta β = 0.210, t = 4.277, and $p < 0.05$. The coefficient indicates that each unit increase in PV adoption success improves the use of sustainable energy practices by 0.201 units. The t-value confirms robustness, and the p-value demonstrates statistical significance at 95% confidence level.

Table 5: ANOVA test

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	54.893	5	10.979	204.43	.000
	Residual	14.598	273	.053		
	Total	69.491	278			

The ANOVA results assessed whether the factors included in the model significantly explain the variation in outcomes related to the PV adoption success in Taita Taveta County. The regression sum of squares (54.893) represents the variation in outcomes explained by the model, whereas the residual sum of squares (14.598) captures unexplained variation. The mean square for regression (10.979) compared to the mean square for residual (0.053) produces an F-value of 204.43, which is very large, indicating that the model was highly significant. The p-value (0.000) confirms that the relationship is statistically significant, showing that PV adoption success strongly influences social, economic, environmental, and sustainable energy outcomes.

CONCLUSIONS

Although Kenya lies within the tropical zone and receives abundant solar radiation throughout the year, the uptake of solar technology remains low among rural populations due to high installation costs, limited financing, and inadequate awareness. In Taita Taveta County, where solar irradiance averages 4–6 kWh/m², many households remain off-grid and depend on non-renewable sources like kerosene and firewood, resulting in persistent energy poverty, health risks, and environmental degradation.

The findings revealed that PV adoption success is positively influenced by social, economic, and environmental factors, while adoption challenges exert a negative effect. The regression and correlation analyses confirmed significant relationships between the dependent and independent variables, indicating that as economic and social benefits increase and environmental awareness improves, the success of PV adoption rises correspondingly. Conversely, high installation costs, inadequate financing, and limited technical knowledge were found to hinder adoption success.

Among the predictors, economic impacts exhibited the strongest influence, emphasizing that affordability, income levels, and perceived financial returns are critical determinants of successful PV system uptake in Taita Taveta County. The diagnostic tests further confirmed the validity and reliability of the regression model, ensuring that the results were statistically sound and representative.

The study indicates that the success of PV adoption in rural Kenya depends on an enabling environment that integrates economic incentives, community awareness, and institutional support. The research demonstrates that when households perceive tangible economic savings, social benefits, and environmental improvements, the likelihood of adopting and sustaining PV systems increases significantly. To strengthen adoption success, policy interventions should prioritize cost-reduction measures, accessible credit facilities, and continuous capacity building to enhance technical skills and awareness. When these determinants are properly addressed, stakeholders can improve the adoption rate, ensure the long-term sustainability of PV systems, and accelerate Kenya’s transition toward clean, reliable, and inclusive rural energy development.

RECOMMENDATIONS

In light of the research findings, it is recommended that the Taita Taveta County Government, the National Government, and development partners establish affordable financing mechanisms and subsidy programs to mitigate the high upfront costs of photovoltaic (PV) systems. The study revealed that economic barriers, particularly installation costs and limited financing options, were major constraints affecting PV adoption success. Access to credit, flexible payment models, and targeted subsidies for low-income households would directly address these barriers, enabling broader adoption among off-grid communities.

Secondly, the study recommends strengthening capacity-building and technical support programs to enhance awareness, ensure proper installation, and promote sustainable utilization of PV systems. The findings indicated that technical gaps and inadequate awareness hindered optimal performance and long-term reliability of PV systems. Therefore, community-based training, empowerment of local technicians, and continuous sensitization on the social, economic, and environmental benefits of PV adoption are essential. These initiatives would contribute to improving social impacts such as education, health services, and community welfare by ensuring that PV systems are efficiently used and maintained.

Finally, it is recommended that policymakers integrate PV adoption into rural development and county energy planning frameworks. The study established that PV systems generate multidimensional benefits, including increased household income, reduced reliance on non-renewable energy sources, and lower environmental degradation. Mainstreaming PV initiatives into Kenya’s renewable energy strategies particularly in sectors such as agriculture, healthcare, education, and small-scale enterprises would amplify these positive outcomes. By embedding PV systems within broader development policies, Taita Taveta County and the national government can strengthen environmental conservation, improve livelihoods, and accelerate the country’s transition toward sustainable and inclusive rural energy development.

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