

GENDER-BASED ANALYSIS OF ATTITUDES TOWARDS RENEWABLE ENERGY PROJECTS AND THEIR SUCCESS RATE: A STATISTICAL EVALUATION

Pranjali Tripathi

Student, Department of science

Ms. Tanuja Khan

Assistant Professor, Department of Psychology

The Bhopal School of Social Sciences

tripathipranjali473@gmail.com

Abstract

The shift to renewable energy is a crucial step in combating climate change and promoting sustainable development. This study explores advancements, challenges, and future prospects of key renewable energy technologies—solar, wind, hydropower, biomass, and geothermal. It examines their environmental, economic, and social impacts, assessing their potential to replace fossil fuels while meeting global energy demands. The study combines the latest advances in energy storage, grid integration, and policy frameworks, underlining the importance of innovation and cooperation in addressing barriers.

Keywords: *Renewable Energy, Attitudes, Success Rates, Gender Differences, Demographic Factors, Factor Analysis, Scale Reliability, Statistical Analysis*

Introduction

To accelerate the global shift toward a cleaner and more resilient energy future. Introduction
With climate change, resource depletion, and energy security concerns increasingly critical, the world is gradually drifting away from fossil fuels and shifting toward renewable energy. Renewable energy has gained immense importance in reducing greenhouse gas emissions while guaranteeing reliable energy supply for the world's rapidly expanding population.

Unlike fossil fuels, renewable sources such as solar, wind, hydropower, geothermal, and biomass offer a continuous, environmentally friendly way to power the future. However, a complete transition to renewables comes with technical, economic, and policy-related challenges. Technological advancements have driven remarkable progress in renewable energy. Solar panels and wind turbines are more efficient than ever, and innovations in energy storage—especially lithium-ion batteries—have made renewables more reliable. Smart grids and artificial intelligence further improve energy management, making integration into national and regional energy systems smoother. These developments mark a major turning point, enabling industries, transportation, and households to move toward decarbonization. Despite this progress, widespread adoption remains uneven. The variability of solar and wind energy—dependent on weather and time of day—requires better storage solutions and more flexible grids to ensure a stable power supply. Infrastructure gaps, such as outdated transmission lines, complicate large-scale adoption. Additionally, the extraction of rare earth metals for renewable technologies raises environmental concerns, emphasizing the need for sustainable supply chains and recycling programs. Economics play a crucial role in renewable energy adoption. While the cost of renewables has decreased, initial investments in infrastructure and grid upgrades remain high. Many developing nations, rich in renewable resources, struggle with financing and policy support. Energy equity is another key issue—ensuring that underserved Communities also benefit from the shift to clean energy. This paper gives an all-inclusive analysis of renewable energy progress, challenges, and future opportunities. By looking at technological innovations, economic trends, and policy measures, the research will try to identify strategies that can increase the adoption of renewables globally. In the end, this study explains how renewables can support both sustainability and energy security while addressing the complex challenges of modern energy systems.

Literature Review

This literature review explores key renewable energy technologies, their environmental impact, economic viability, and the policies shaping their adoption.

Renewable Energy Technologies

Solar and wind energy are leading the renewable revolution due to rapid advancements and cost reductions. Solar photovoltaics (PV) have seen major efficiency improvements, with

perovskite cells emerging as a breakthrough technology (Zhou et al., 2020). Wind energy has also progressed with better turbine designs and offshore installations, improving energy output (IEA, 2022). Other innovations, such as floating solar panels and enhanced geothermal systems, offer new possibilities for renewable expansion (Kumar et al., 2021). A major challenge in renewable adoption is energy storage. While lithium-ion batteries remain the dominant technology, research into solid-state batteries and hydrogen storage is ongoing (Chen et al., 2022). Additionally, smart grids and decentralized energy systems are helping integrate renewables more efficiently (Zhang et al., 2021).

Environmental Implications

Renewable energy significantly reduces carbon emissions and contributes to global climate goals (UNEP, 2021). However, concerns about the environmental footprint of renewable infrastructure—such as the mining of Rare earth elements for solar panels and wind turbines—must be addressed.. Research on recycling and circular economy models is gaining importance in ensuring sustainability (Wei et al., 2023).

Economic Viability

The cost of renewable energy has dropped dramatically, making it competitive with fossil fuels (IRENA, 2023). Additionally, the renewable sector is a major driver of job creation, particularly in emerging economies (IRENA, 2021). However, financial and logistical barriers, particularly in developing countries, remain a challenge..

Policy Frameworks and Global Trends

Government policies play a vital role in renewable energy adoption. Incentives like subsidies, tax breaks, and carbon pricing have proven effective (Sovacool et al., 2022). International agreements, such as the Paris Agreement, have set ambitious targets for clean energy transitions (IPCC, 2021). However, inconsistent policies and a lack of long-term planning hinder progress in some regions (Rao et al., 2020).

Future Challenges and Opportunities

While progress has been substantial, obstacles such as intermittency, grid stability, and public resistance persist. Researchers stress the need for continued advancements in energy storage and infrastructure modernization. Collaboration between governments, industries, and

research institutions is essential to fostering innovation and ensuring a just energy transition (Li et al., 2022). This literature review underscores the significant strides made in renewable energy while highlighting areas that require further attention.

Significance of the Study

The transition to renewable energy is essential for combating climate change and ensuring energy security. This study examines how renewables can meet global energy demands while reducing reliance on fossil fuels. By exploring key technological advancements—such as energy storage and smart grids—this research highlights how innovation can overcome common barriers like intermittency and grid integration. The study also emphasizes the economic potential of renewable energy, demonstrating its role in job creation, investment, and long-term cost reductions. Energy equity is another focus, particularly in developing regions where access to clean, affordable energy remains limited. The study also evaluates existing policies, identifying gaps and proposing strategies to accelerate renewable adoption worldwide.

Objectives

- To analyze whether attitudes toward renewable energy vary across different age groups.
- To assess whether gender influences perceptions and engagement with renewable energy initiatives.

Research Gap

Despite extensive research on renewable energy, key gaps remain. Many studies focus on individual technologies but lack insights into how they integrate into existing energy systems. This study explores modern grid updates and energy storage improvements to enhance renewable reliability.

Additionally, while renewable costs have dropped, financial barriers remain—especially in developing nations. This research identifies strategies for ensuring equitable access to renewable energy. The environmental impact of materials used in renewable technologies, such as rare earth metals, is another overlooked area. Public resistance to large-scale projects like wind farms also requires attention. Addressing these gaps, this study provides a framework for advancing renewable adoption worldwide.

Research Methodology

This study employed a quantitative, cross-sectional survey design to investigate the relationship between demographic factors (age, gender, education, occupation, and income) and attitudes toward renewable energy and success rates. Data were collected from 77 participants using an online questionnaire, with 38 valid responses analyzed. The questionnaire consisted of demographic questions and Likert-scale items measuring attitudes and perceptions of renewable energy and success rates. Statistical analyses included descriptive statistics, scale reliability (Cronbach's $\alpha = 0.826$), independent samples t-tests to compare male and female attitudes and success rates, and factor analysis using the "minimum residual" extraction method with oblimin rotation, which revealed a unidimensional structure (factor loading = 0.840). Ethical considerations, such as informed consent, confidentiality, and adherence to research ethics, were rigorously observed throughout the study.

Hypotheses

Null Hypothesis (H_0): There is no significant difference in attitudes toward renewable energy between males and females.

Null Hypothesis (H_0): There is no significant difference in success rates between males and females

Data Analyses

Descriptives									
		AG		GEN		EDU		OCC	
N		38		38		38		38	
Missing		39		39		39		39	
Mean		2.05		1.84		2.00		1.11	

Median	2.00	2.00	2.00	1.00	2.00
Standard deviation	0.695	0.370	0.615	0.388	1.85
Minimum	1	1	1	1	1
Maximum	5	2	4	3	5
Skewness	2.47	-1.95	0.735	3.99	0.357
Std. error skewness	0.383	0.383	0.383	0.383	0.383
Kurtosis	9.73	1.92	2.51	16.6	-1.82
Std. error kurtosis	0.750	0.750	0.750	0.750	0.750
Shapiro-Wilk W	0.536	0.439	0.728	0.302	0.716
Shapiro-Wilk p	< .001	< .001	< .001	< .001	< .001

Interpretation: The descriptive analysis reveals notable patterns across demographic variables. Age (AG) and Occupation (OCC) are positively skewed with leptokurtic distributions, indicating responses clustered at lower levels, while Gender (GEN) is negatively skewed, suggesting a concentration around one category (likely "Female"). Education (EDU) and Monthly Income (MON) exhibit mild skewness, with MON showing the highest variability (SD = 1.85) due to a wide income range. Shapiro-Wilk tests confirm significant deviations from normality for all variables ($p < 0.001$), necessitating non-parametric methods for further analysis. These patterns highlight demographic diversity and the need to account for non-normal distributions when evaluating attitudes toward renewable energy.

Null Hypothesis (H_0): There is no significant difference in attitudes toward renewable energy between males and females.

Null Hypothesis (H_0): There is no significant difference in success rates between males and females

Independent Samples T-Test								
				Statistic		df		p
Renewable Energy		Student's t		-0.6706	^a	36.0		0.507
Success Rate		Student's t		0.0718		36.0		0.943

Note. $H_a \mu_{\text{Male}} \neq \mu_{\text{Female}}$

^a Levene's test is significant ($p < .05$), suggesting a violation of the assumption of equal variances

Interpretation

Renewable Energy

The t-test result for attitudes toward renewable energy ($t = -0.6706, df = 36, p = 0.507$) indicates no statistically significant difference between males and females, as the p-value is greater than 0.05. Although Levene's test for equal variances is significant ($p < 0.05$), suggesting a violation of the equal variances assumption, this does not impact the conclusion due to the non-significant p-value. Thus, gender does not appear to influence attitudes toward renewable energy in this sample.

Success Rate

The t-test result for success rate ($t = 0.0718, df = 36, p = 0.943$) similarly indicates no significant difference between males

and females, with a p-value far above 0.05. This shows that gender has no meaningful impact on success rates.

Discussion

This study explored the relationships between demographic factors (age, gender, education, occupation, and income) and attitudes toward renewable energy and success rates. The findings revealed no statistically significant differences in attitudes or success rates based on gender, as indicated by the independent samples t-tests ($p > 0.05$). These results suggest that gender does not play a critical role in shaping perceptions or influencing success rates in renewable energy initiatives. Furthermore, the reliability analysis demonstrated strong internal consistency for the scale (Cronbach's $\alpha = 0.826$), indicating that the items effectively measured the constructs of interest. Factor analysis revealed a unidimensional structure, with both items—attitudes toward renewable energy and success rates—loading strongly onto a single factor (loading = 0.840), underscoring their interconnectedness.

The descriptive statistics highlighted demographic diversity within the sample, with skewness and kurtosis indicating deviations from normality, particularly in age and occupation. These findings align with the broader literature, which emphasizes the role of socioeconomic and cultural factors in shaping attitudes toward renewable energy. However, the absence of significant differences across gender groups challenges some assumptions in the literature, potentially reflecting a more equitable distribution of awareness and engagement in the context of renewable energy within this sample.

The results must be interpreted with caution due to the small sample size and significant missing data. Additionally, the violation of assumptions in Levene's test for equality of variances suggests the need for further investigation using larger, more representative samples and advanced statistical techniques.

Conclusions

This study finds no significant gender-based differences in attitudes toward renewable energy or success rates. The reliability analysis confirms the validity of the measurement scale, emphasizing the potential for widespread engagement with renewable initiatives, regardless of gender. While these findings are valuable, the study acknowledges limitations, such as a

small sample size. Future research should explore larger, more diverse populations to validate these conclusions further. Expanding demographic analysis and addressing policy barriers will provide deeper insights into the factors influencing renewable energy adoption.

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