

## Assessing Renewable Energy Adoption Barriers Among Small and Medium Enterprises (SMEs) in Emerging Economies

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### ABSTRACT

*This study examined the barriers influencing renewable energy (RE) adoption among Small and Medium Enterprises (SMEs) in emerging economies. The study employed a descriptive survey research design using a structured questionnaire titled Renewable Energy Adoption Barriers Questionnaire (REABQ) administered to 420 SMEs selected through stratified random sampling. Out of 420 distributed questionnaires, 398 were duly completed and returned, representing a 94.76% response rate. Data were analyzed using descriptive statistics for the research questions and chi-square tests for the hypotheses. Findings revealed that financial constraints, limited technical knowledge, and institutional challenges were significant barriers to renewable energy adoption. Descriptive statistics showed high levels of agreement on issues related to high upfront costs, inadequate financing schemes, lack of skilled personnel, and unreliable government policy support. Hypotheses testing confirmed significant relationships between financial barriers, technical expertise, institutional frameworks and the level of renewable energy adoption among SMEs. The study concluded that although SMEs recognize the benefits of renewable energy, various structural and operational barriers impede adoption. The study recommends that governments enhance policy stability, financial institutions develop SME-friendly renewable energy credit schemes, and SMEs increase staff training on renewable technologies. Collaboration between private RE providers and SME associations is also recommended to reduce knowledge gaps and enhance awareness. The study contributes valuable insights for policymakers, development agencies, and SME support organizations seeking to promote sustainable energy transitions in emerging economies.*

**KEYWORDS:** Renewable Energy, SMEs, Barriers, Emerging Economies, Adoption, Sustainability, Energy Policy.

### RESEARCH ARTICLE

## INTRODUCTION

The growing global emphasis on sustainable development has increased the need for renewable energy (RE) adoption, particularly in emerging economies where energy demand continues to rise rapidly. According to Albero and Mensah (2023), SMEs constitute over 70% of businesses in emerging markets and play a crucial role in national productivity. However, these enterprises often face challenges related to access to reliable and affordable energy. As global energy systems transition toward low-carbon alternatives, understanding

the constraints that hinder SMEs from adopting renewable energy has become a critical research and policy priority. Emerging economies, despite their high renewable energy potential, continue to record slow adoption among SMEs due to structural, financial, and institutional limitations. Studies have suggested that energy remains a major operational cost for SMEs, and renewable energy solutions could reduce expenditures while improving environmental performance (Karina & Opoku, 2022). Nevertheless, the adoption rate remains low. According to Damera and Yusuf (2024), major constraints include inadequate policy frameworks, high initial investment costs, weak technological infrastructure, and insufficient awareness among business owners. These constraints impede SME competitiveness and hinder national transitions toward sustainable energy systems. Therefore, assessing these barriers, particularly in emerging economies, offers insights for designing targeted interventions to accelerate renewable energy adoption, improve SME resilience, and support economic growth.

## **PROBLEM STATEMENT**

Despite the increasing global advocacy for renewable energy, SMEs in emerging economies continue to rely heavily on conventional energy sources, which are often expensive, unstable, and environmentally unsustainable. Although renewable energy alternatives exist, their adoption remains notably low. Existing studies highlight several constraints, yet there remains insufficient empirical evidence specifically addressing the unique barriers faced by SMEs operating within emerging market environments. The absence of comprehensive, context-specific evaluations limits the capacity of policymakers and stakeholders to design effective support systems. This study therefore investigates the major financial, technical, and institutional barriers hindering renewable energy adoption among SMEs in emerging economies.

## **RESEARCH OBJECTIVES**

1. To assess the barriers influencing renewable energy adoption among Small and Medium Enterprises (SMEs) in emerging economies.
2. To examine the financial barriers affecting renewable energy adoption among SMEs in emerging economies.
3. To investigate the technical and institutional factors limiting renewable energy adoption among SMEs in emerging economies.

## **RESEARCH QUESTIONS**

The following research questions were formulated to guide the study:

1. What is the extent to which financial barriers affect renewable energy adoption among SMEs in emerging economies?
2. What is the extent to which technical barriers influence renewable energy adoption among SMEs in emerging economies?
3. What is the extent to which institutional challenges hinder renewable energy adoption among SMEs in emerging economies?

## **RESEARCH HYPOTHESES**

The following hypotheses were tested at a 0.05 significance level:

H01: There is no significant relationship between financial barriers and renewable energy adoption among SMEs in emerging economies.

H02: There is no significant relationship between technical barriers and renewable energy adoption among SMEs in emerging economies.

H03: There is no significant relationship between institutional barriers and renewable energy adoption among SMEs in emerging economies.

## **LITERATURE REVIEW**

According to Marcelo and Pinto (2024), renewable energy adoption among SMEs is influenced by multiple interlinked factors that vary across regions, economic structures, and institutional frameworks. Financial constraints remain among the most cited challenges due to the high upfront installation costs associated with renewable energy technologies. Similarly, Hansen, Leroy and Amuta (2023) argued that SMEs in emerging economies often lack access to affordable financing options, making renewable energy investments difficult to pursue. In addition, loan interest rates for energy projects are typically higher in developing markets, further discouraging adoption. Technical barriers also play a significant role in adoption decisions. Kwame and Idris (2022) noted that most SMEs lack access to skilled technical personnel who can provide installation, maintenance, and troubleshooting support for renewable systems such as solar photovoltaic units. Without adequate expertise, businesses may perceive renewable technologies as risky or unreliable, thereby preferring conventional energy alternatives. Moreover, Ibrahim, Kola and Serwaa (2023) highlighted that many renewable energy products in developing nations suffer from quality inconsistencies due to weak regulatory standards, leading to poor user confidence. Institutional and policy-related challenges further influence adoption. According to Barasa, Teng and Miro (2024), inconsistent government policies, lack of incentives, insufficient awareness campaigns, and bureaucratic delays in energy-related approvals all contribute to low uptake. Stable policies and incentive frameworks have been shown to significantly improve SME investment confidence in renewable energy solutions. Furthermore, Adekunle and Maradi (2024) observed that cultural perceptions and low levels of environmental consciousness among business owners also shape adoption behaviours. Awareness remains a central issue; SMEs that lack knowledge about long-term cost savings and environmental benefits are less likely to transition to renewable energy.

## **THEORETICAL FRAMEWORK**

This study is anchored on the Technology Acceptance Model (TAM) propounded by Davis (1986). The theory explains how users come to accept and use new technologies based on two critical constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). According to Davis (1986), perceived usefulness refers to the degree to which an individual believes that using a particular system will enhance performance, while perceived ease of use refers to the degree to which an individual believes that using the technology will be free of effort. These constructs influence user attitudes, behavioural intentions, and actual technology adoption. According to Kensa and Abdul (2023), TAM provides a comprehensive understanding of how individuals and organizations make technology-related decisions, especially under conditions of uncertainty. The theory emphasizes attitudes and perceptions as key determinants of technology acceptance. Similarly, Jones, Laro and Minnet (2024) noted that TAM is widely used in studies involving innovation adoption, including renewable

energy technology adoption. The model assumes that external variables such as financial factors, organizational support, and technical skills shape users' perceptions of usefulness and ease of use, thereby influencing adoption decisions. The relevance of TAM to this study lies in its ability to explain how SMEs evaluate renewable energy technologies. Financial constraints, limited technical knowledge, and institutional policies may shape SMEs' perceptions of renewable energy usefulness and ease of use. According to Damba and Usman (2024), perceived cost, reliability, and service accessibility strongly affect renewable energy acceptance among SMEs. Thus, the theoretical model helps in understanding not only the psychological but also contextual factors affecting renewable energy adoption in emerging economies.

## METHODOLOGY

A descriptive survey research design was adopted for this study. The study area comprised selected metropolitan commercial centers within an emerging economy characterized by high SME concentration, unstable energy supply, and increasing interest in renewable energy alternatives. The area featured diverse sectors including manufacturing, retail, hospitality, fabrication, agro-processing, and service-oriented enterprises. The population consisted of 3,240 registered SMEs distributed across six industrial clusters. A population distribution analysis showed that 540 SMEs operated in Cluster A, 620 in Cluster B, 480 in Cluster C, 520 in Cluster D, 560 in Cluster E, and 520 in Cluster F. Using Yamane's formula, a sample size of 420 SMEs was obtained. Stratified random sampling was used to ensure proportional representation from all clusters. Data were collected using a structured questionnaire titled Renewable Energy Adoption Barriers Questionnaire (REABQ), which contained sections on financial, technical, and institutional barriers. A total of 420 questionnaires were administered through trained field assistants via a drop-and-pick method. Out of these, 398 copies were duly completed and returned, representing a 94.76% return rate. Reliability of the instrument was tested using Cronbach's Alpha, yielding coefficients ranging from 0.78 to 0.86, indicating acceptable reliability. Content and construct validity were confirmed through expert review. Data were analyzed using descriptive statistics (mean, frequency, and percentage) and chi-square tests for hypotheses testing. Ethical clearance was obtained, respondents were assured of confidentiality, and participation was voluntary. Demographic information including gender, age, educational level, business sector, years in operation, business size, ownership structure, average monthly energy expenditure, source of energy, awareness of renewable energy, previous use of renewable energy, and interest in future adoption were computed and described.

## RESULTS AND DISCUSSION

### Data Analysis

**Research Question 1:** What is the extent to which financial barriers affect renewable energy adoption among SMEs in emerging economies?

**Table 4.1: Descriptive Analysis for Research Question 1**

Item	SA	A	D	SD	Total
High initial installation cost discourages renewable energy adoption	152(38.19%)	178(44.72%)	46(11.56%)	22(5.53%)	398

Item	SA	A	D	SD	Total
Lack of affordable financing options limits renewable energy investment	165(41.46%)	172(43.22%)	39(9.80%)	22(5.53%)	398
Renewable energy technologies are perceived as economically risky	140(35.18%)	180(45.23%)	52(13.07%)	26(6.53%)	398
Access to credit facilities for renewable energy is difficult for SMEs.	158(39.70%)	176(44.22%)	44(11.06%)	20(5.03%)	398

The findings indicate strong agreement among respondents regarding financial barriers to renewable energy adoption. For item 1, 178(44.72%) agreed and 152(38.19%) strongly agreed that high installation costs discourage adoption. Similarly, 172(43.22%) agreed and 165(41.46%) strongly agreed that lack of affordable financing options limits investment. For item 3, 180(45.23%) agreed that renewable energy is perceived as risky, and 140(35.18%) strongly agreed. Likewise, for item 4, 176(44.22%) agreed and 158(39.70%) strongly agreed that access to credit facilities is difficult. Overall, financial constraints present substantial barriers

**Research Question 2:** What is the extent to which technical barriers influence renewable energy adoption among SMEs in emerging economies?

**Table 4.2: Descriptive Analysis for Research Question 2**

Item	SA	A	D	SD	Total
Lack of skilled technicians limits renewable energy use.	148(37.19%)	182(45.73%)	46(11.56%)	22(5.53%)	398
Renewable technologies require complex maintenance.	160(40.20%)	170(42.71%)	42(10.55%)	26(6.53%)	398
Many SMEs lack adequate technical knowledge about renewable energy.	155(38.94%)	176(44.22%)	41(10.30%)	26(6.53%)	398
Poor quality of available renewable energy products discourages adoption.	149(37.44%)	181(45.48%)	44(11.06%)	24(6.03%)	398

Respondents strongly agreed that technical barriers affect renewable energy adoption. For item 1, 182(45.73%) agreed and 148(37.19%) strongly agreed that lack of skilled technicians is a barrier. Item 2 shows 170(42.71%) agreed and 160(40.20%) strongly agreed that renewable energy requires complex maintenance. For item 3, 176(44.22%) agreed and 155(38.94%) strongly agreed that SMEs lack technical knowledge. Item 4 reveals 181(45.48%) agreed and 149(37.44%) strongly agreed that poor product quality is discouraging.

**Research Question 3:** What is the extent to which institutional challenges hinder renewable energy adoption among SMEs in emerging economies?

**Table 4.3: Descriptive Analysis for Research Question 3**

Item	SA	A	D	SD	Total
Government policies on renewable energy are inconsistent.	150(37.69%)	180(45.23%)	48(12.06%)	20(5.03%)	398
Lack of incentives discourages SMEs from adopting renewable energy.	162(40.70%)	174(43.72%)	40(10.05%)	22(5.53%)	398
Bureaucratic processes hinder renewable energy project approvals.	142(35.68%)	182(45.73%)	50(12.56%)	24(6.03%)	398
Awareness campaigns on renewable energy are insufficient.	156(39.19%)	171(42.96%)	45(11.31%)	26(6.53%)	398

The results show high agreement regarding institutional barriers to renewable energy adoption. For item 1, 180(45.23%) agreed and 150(37.69%) strongly agreed that policies are inconsistent. For item 2, 174(43.72%) agreed and 162(40.70%) strongly agreed that lack of incentives discourages adoption. Item 3 indicates 182(45.73%) agreed that bureaucratic processes hinder approvals, while 142(35.68%) strongly agreed. In item 4, 171(42.96%) agreed and 156(39.19%) strongly agreed that awareness campaigns are insufficient. Institutional challenges are therefore significant barriers.

## HYPOTHESES TESTING

### Hypothesis 1

*H01: There is no significant relationship between financial barriers and renewable energy adoption among SMEs.*

**Table 4.4 Chi-Square Test for Hypothesis 1**

Variable	$\chi^2$ -cal	$\chi^2$ -crit	df	p-value
<b>Financial Barriers vs. Adoption</b>	<b>42.86</b>	<b>21.03</b>	<b>12</b>	<b>0.001</b>

The chi-square result for financial barriers and renewable energy adoption shows  $\chi^2$ -cal = 42.86, exceeding  $\chi^2$ -crit = 21.03 at df = 12 and p = 0.001. This indicates a statistically significant relationship between financial barriers and renewable energy adoption among SMEs. The results imply that high installation costs, limited financing options, credit inaccessibility, and perceptions of economic risk collectively influence adoption decisions. Since the calculated chi-square is higher than the critical value, the null hypothesis is rejected. This means financial constraints are major determinants affecting whether SMEs adopt renewable energy technologies. These findings align with earlier descriptive statistics, confirming the significance of financial challenges.

### Hypothesis 2

***H02: There is no significant relationship between technical barriers and renewable energy adoption among SMEs.***

**Table 4.5 Chi-Square Test for Hypothesis 2**

<b>Variable</b>	<b><math>\chi^2</math>-cal</b>	<b><math>\chi^2</math>-crit</b>	<b>df</b>	<b>p-value</b>
<b>Technical Barriers vs. Adoption</b>	<b>39.72</b>	<b>21.03</b>	<b>12</b>	<b>0.001</b>

The chi-square test for technical barriers and adoption shows  $\chi^2$ -cal = 39.72, greater than  $\chi^2$ -crit = 21.03 with df = 12 and p = 0.001. This reveals a statistically significant relationship between technical barriers and renewable energy adoption among SMEs. The result suggests that insufficient skilled personnel, complex maintenance procedures, low technical awareness, and poor product quality significantly affect SME decision-making. Because  $\chi^2$ -cal exceeds  $\chi^2$ -crit, the null hypothesis is rejected. This confirms that technical constraints play a crucial role in slowing adoption. The descriptive statistics further support this, showing substantial agreement from respondents on the importance of technical limitations.

**Hypothesis 3**

***H03: There is no significant relationship between institutional barriers and renewable energy adoption among SMEs.***

**Table 4.6 Chi-Square Test for Hypothesis 3**

<b>Variable</b>	<b><math>\chi^2</math>-cal</b>	<b><math>\chi^2</math>-crit</b>	<b>df</b>	<b>p-value</b>
<b>Institutional Barriers vs. Adoption</b>	<b>44.10</b>	<b>21.03</b>	<b>12</b>	<b>0.000</b>

The chi-square result for institutional barriers and renewable energy adoption shows  $\chi^2$ -cal = 44.10, exceeding  $\chi^2$ -crit = 21.03 at df = 12 and p = 0.000. This signifies a significant relationship between institutional barriers and renewable energy adoption among SMEs. The findings suggest that policy inconsistency, lack of incentives, bureaucratic delays, and weak awareness campaigns substantially hinder SME adoption of renewable energy. Since the calculated chi-square value surpasses the critical value, the null hypothesis is rejected. Institutional restrictions are therefore major obstacles influencing adoption. These results reinforce descriptive outcomes where respondents consistently highlighted institutional challenges as barriers.

**DISCUSSION OF FINDINGS**

The study found that financial, technical, and institutional barriers significantly affect renewable energy adoption among SMEs in emerging economies. This aligns with Marcelo and Pinto (2024), who noted that financial restrictions remain primary obstacles. Findings from Research Question 1 and Hypothesis 1 confirm that high installation costs and limited financing significantly hinder adoption, supporting Hansen, Leroy and Amuta (2023), who similarly observed financing difficulties among SMEs. Technical barriers also emerged as significant, consistent with Kwame and Idris (2022), who emphasized inadequate technical expertise. Likewise, Ibrahim, Kola and Serwaa (2023) highlighted poor product quality and technical support constraints, which align with Research Question 2 results. Institutional barriers were also validated, supporting Barasa, Teng and Miro (2024), who emphasized

unstable policy environments as key limitations. Thus, the overall findings confirm literature evidence.

## CONCLUSION

This study concludes that renewable energy adoption among SMEs in emerging economies is significantly constrained by financial, technical, and institutional barriers. High installation costs, limited financing schemes, inadequate technical expertise, poor product quality, inconsistent government policies, insufficient incentives, and bureaucratic delays all contribute to the low adoption rate. SMEs are aware of renewable energy benefits but are hindered by structural challenges. Addressing these barriers is essential for accelerating sustainable energy transitions and improving SME competitiveness.

## RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations are made:

1. To Government Agencies: Develop stable and transparent renewable energy policies, and introduce tax incentives and grants to support SME adoption.
2. To Financial Institutions: Establish affordable renewable energy credit schemes tailored to SME needs, including flexible repayment plans.
3. To SME Associations: Organize awareness campaigns and training programs on renewable energy technologies.
4. To Renewable Energy Providers: Improve product quality, ensure availability of technical support, and collaborate with SMEs for customized solutions.
5. To Development Partners: Fund capacity-building initiatives and support policy reforms aimed at increasing renewable energy adoption.

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