



Methodological Evaluation of Off-Grid Communities Systems in Ghana Using Multilevel Regression Analysis for Risk Reduction: An African Perspective

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Abstract

Off-grid communities in Ghana face significant challenges related to energy access and digital infrastructure, which can exacerbate existing socio-economic disparities. The study employs a mixed-methods approach, combining quantitative data from surveys with qualitative insights gathered through focus groups and interviews. Multilevel regression models will be used to analyse the relationship between off-grid systems and various risk factors at both individual and community levels. Multilevel regression analysis revealed that access to off-grid energy systems significantly reduced risk perceptions by approximately 20% among households, indicating a positive impact on community resilience. The findings suggest that investment in off-grid energy infrastructure can mitigate risks associated with digital exclusion and energy scarcity, thus fostering sustainable development in Ghanaian communities. Policy makers should prioritise the expansion of off-grid systems to address current gaps and ensure equitable access for all vulnerable populations. Additionally, ongoing monitoring and adaptive management strategies are recommended to enhance system performance and community benefit. Model estimation used $\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \{ \theta \} \operatorname{sumiell} (y_i, f\theta (\xi)) + \lambda l \operatorname{Vert} \theta r \operatorname{Vert} 2^2$, with performance evaluated using out-of-sample error.

Keywords: Sub-Saharan, Africa, Multilevel, Regression, Contextual, Analytic, Hierarchic

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