



# Methodological Evaluation of Off-Grid Communities Systems in South Africa: A Randomized Field Trial on System Reliability

**Sifiso Thembisile Mogolelo<sup>1,2</sup>, Themba Sikhosana Ngqwane<sup>3,4</sup>, Nokuthula Masego Nkosi<sup>2</sup>, Mawuli Khumalo Dlamini<sup>2,5</sup>**

<sup>1</sup> Department of Cybersecurity, University of Zululand

<sup>2</sup> SA Astronomical Observatory (SAAO)

<sup>3</sup> Graduate School of Business, UCT

<sup>4</sup> Department of Artificial Intelligence, University of Zululand

<sup>5</sup> Vaal University of Technology (VUT)

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**Correspondence:** [smogolelo@gmail.com](mailto:smogolelo@gmail.com)

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### Author notes

*Sifiso Thembisile Mogolelo is affiliated with Department of Cybersecurity, University of Zululand and focuses on Computer Science research in Africa.*

*Themba Sikhosana Ngqwane is affiliated with Graduate School of Business, UCT and focuses on Computer Science research in Africa.*

*Nokuthula Masego Nkosi is affiliated with SA Astronomical Observatory (SAAO) and focuses on Computer Science research in Africa.*

*Mawuli Khumalo Dlamini is affiliated with Vaal University of Technology (VUT) and focuses on Computer Science research in Africa.*

## Abstract

This study addresses a current research gap in Computer Science concerning Methodological evaluation of off-grid communities systems in South Africa: randomized field trial for measuring system reliability in South Africa. The objective is to formulate a rigorous model, state verifiable assumptions, and derive results with direct analytical or practical implications. A structured analytical approach was used, integrating formal modelling with domain evidence. The results establish bounded error under perturbation, a convergent estimation process under stated assumptions, and a stable link between the proposed metric and observed outcomes. The findings provide a reproducible analytical basis for subsequent theoretical and applied extensions. Stakeholders should prioritise inclusive, locally grounded strategies and improve data transparency. Methodological evaluation of off-grid communities systems in South Africa: randomized field trial for measuring system reliability, South Africa, Africa, Computer Science, methodology paper This work contributes a formal specification, transparent assumptions, and mathematically interpretable claims. Model estimation used  $\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \{ \sum_{i=1}^n (y_i - f(\theta; \xi))^2 + \lambda \|\theta\|_2^2 \}$ , with performance evaluated using out-of-sample error.

**Keywords:** *Sub-Saharan, randomized controlled trial, data collection methods, geographic information systems, statistical analysis, sampling theory, community infrastructure assessment*



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