

Methodological Evaluation and Panel-Data Estimation of Industrial Machinery Fleet System Reliability in Nigeria, 2000–2026

Fatima Sani^{1,2}|Chinelo Okonkwo^{3,4}
Adebayo Adeyemi^{5,6}|Chukwuma Nwachukwu⁶

¹ University of Calabar

² University of Ibadan

³ Department of Mechanical Engineering, Bayero University Kano

⁴ Department of Mechanical Engineering, Usmanu Danfodiyo University, Sokoto

⁵ Usmanu Danfodiyo University, Sokoto

⁶ Department of Mechanical Engineering, University of Ibadan

Correspondence: fsani@outlook.com

Received: 06 May 2026 | Accepted: 17 August 2026 | Published: 05 October 2026 | DOI:

[10.5281/zenodo.18969547](https://doi.org/10.5281/zenodo.18969547)

ABSTRACT

Background: Industrial machinery fleet reliability is a critical determinant of productivity and economic output in developing economies. However, systematic, longitudinal assessments of fleet system performance in such contexts are scarce, limiting evidence-based maintenance and replacement strategies.

Purpose and objectives: This study aims to methodologically evaluate approaches for assessing industrial machinery fleet reliability and to develop a robust panel-data model for estimating system-wide reliability trends within a major industrial sector.

Keywords: *Panel-data estimation, System reliability, Industrial machinery fleets, Sub-Saharan Africa, Maintenance engineering, Reliability-centred maintenance, Developing economies*

Article Highlights

- Cross-sectional approaches show significant bias in reliability assessment.
- Unobserved machine heterogeneity accounts for over 30% of failure rate variance.
- Panel-data modelling provides superior framework for capturing dynamic trends.
- Standardised operational data collection is critical for predictive maintenance.

Core Methodology

Generalized linear mixed model for panel data: $\lambda_{it} = \exp(\beta X_{it} + \mu_i + \varepsilon_{it})$, with maximum likelihood estimation and robust standard errors.

This study offers a methodological advance for reliability assessment in industrial contexts.

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

REQUEST FULL PAPER

 **Email:** info@parj.africa

Request your copy of the full paper today!

SUBMIT YOUR RESEARCH

**Are you a researcher in Africa? We
welcome your submissions!**

Join our community of African scholars and share
your groundbreaking work.

 **Submit at:** app.parj.africa



Scan to visit app.parj.africa

Open Access Scholarship from PARJ

Empowering African Research | Advancing Global
Knowledge