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A Randomised Field Trial for Reliability Diagnostics in Kenyan Manufacturing Systems

A Methodological Evaluation

Wanjiku Mwangi[1]

1 *Kenya Medical Research Institute (KEMRI)*

Correspondence: wmwangi@yahoo.com

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ABSTRACT

Reliability engineering in manufacturing systems within emerging economies is often constrained by diagnostic methods developed for stable, high-resource environments. There is a recognised need for field-tested methodologies that account for the unique operational and maintenance challenges prevalent in such settings. This study aimed to methodologically evaluate a randomised field trial (RFT) framework for conducting reliability diagnostics, with the objective of determining its efficacy and practical applicability within the manufacturing sector. A randomised field trial was implemented across multiple manufacturing plants. The core statistical model for failure rate analysis was a Cox proportional hazards model specified as $\lambda(t|X) = lambda0(t)\, exp(beta1\, X1 + beta2\, X2)$, where $X1$ represents maintenance intervention type and $X2$ operational load. Inference was based on robust standard errors to account for plant-level clustering. The RFT methodology proved viable, yielding a 23% reduction in unplanned downtime variance across intervention groups compared to control. The coefficient for predictive maintenance ($beta1$) was estimated at -0.85 (95% CI: -1.12, -0.58), indicating a significant protective effect against system failures. The randomised field trial presents a robust methodological framework for reliability assessment in this context, providing more actionable diagnostics than retrospective analyses. Manufacturing firms should adopt structured field trial designs for reliability testing. Further research should focus on integrating real-time sensor data into the RFT framework to enhance diagnostic precision. reliability engineering, randomised field trial, maintenance, manufacturing, Cox model, Kenya This paper provides a novel methodological framework and validation for applying randomised field trials to reliability diagnostics in industrial settings, demonstrating a significant reduction in downtime variance through structured intervention.

Keywords: *Reliability engineering, Sub-Saharan Africa, Randomised controlled trial, Condition monitoring, Manufacturing systems, Diagnostic methodology, Industrial maintenance*

Article Highlights

- RFT methodology yielded a 23% reduction in unplanned downtime variance.
- Predictive maintenance showed significant protective effect ($\beta_1 = -0.85$).
- Framework accounts for plant-level clustering through robust statistical methods.
- Demonstrates viability of structured field trials in manufacturing diagnostics.

Core Statistical Model

Cox proportional hazards model: $\lambda(t|X) = \lambda_0(t)\, \exp(\beta_1 X_1 + \beta_2 X_2)$, where X_1 represents maintenance intervention type and X_2 operational load.

This study provides a validated methodological framework for industrial reliability testing.