

Comparative Field Trial of Maintenance Regimes for Industrial Machinery Fleets in Kenya

A Risk-Based Methodological Evaluation

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ABSTRACT

{ "background": "Maintenance regimes for industrial machinery fleets in sub-Saharan Africa are often based on fixed schedules or reactive practices, with limited empirical evaluation of their effectiveness in mitigating operational risks within specific regional contexts.", "purpose and objectives": "This study aimed to methodologically evaluate the comparative efficacy of a novel risk-based maintenance (RBM) regime against conventional time-based maintenance (TBM) for industrial machinery fleets, with the primary objective of quantifying associated reductions in critical failure risk.", "methodology": "A randomised field trial was conducted using a fleet of 42 heavy-duty vehicles from three industrial sites. Units were randomly assigned to either the RBM or TBM group. The RBM intervention utilised a proportional hazards model, $\lambda(t|X) = \lambda_0(t) \exp(\beta_1 X_1 + \beta_2 X_2)$, to prioritise tasks based on real-time risk indicators. Key performance metrics, including mean time between critical failures (MTBCF) and downtime cost, were monitored over an operational period.", "findings": "The risk-based regime reduced the incidence of critical failures by 32% (95% CI: 24% to 40%) compared to the time-based approach. Furthermore, analysis using robust standard errors indicated a statistically significant reduction in total unplanned downtime costs per vehicle for the RBM cohort.", "conclusion": "The risk-based methodology demonstrated superior performance in mitigating high-consequence failure events within the studied operational environment, proving its practical viability for asset-intensive industries in the region.", "recommendations": "Industrial operators should adopt risk-based maintenance frameworks, supported by continuous data collection on machine condition and failure history, to optimise resource allocation and improve fleet reliability.", "key words": "risk-based maintenance, field trial, machinery fleet, proportional hazards model, comparative study, asset management", "contribution statement": "This study provides the first randomised field-trial evidence for the efficacy of a formal risk-based maintenance methodology applied to

Keywords: *Comparative analysis, Risk-based maintenance, Industrial machinery fleets, Sub-Saharan Africa, Field trial, Maintenance regimes, Methodological evaluation*

Article Highlights

- Randomised field trial of 42 heavy-duty vehicles across three industrial sites in Kenya.
- Risk-based maintenance reduced critical failures by 32% versus time-based schedules.
- Methodology employed a proportional hazards model to prioritise maintenance tasks.

Methodological Note

The intervention utilised a proportional hazards model, $\lambda(t|X) = \lambda_0(t) \exp(\beta_1 X_1 + \beta_2 X_2)$, to dynamically prioritise maintenance based on real-time risk indicators.

This study provides randomised field-trial evidence for a risk-based maintenance framework in sub-Saharan Africa.

<ul style="list-style-type: none">• Significant reduction in total unplanned downtime costs per vehicle observed.	
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