

COMPARATIVE STUDY

Comparative Cost-Effectiveness of Maintenance Methodologies for Industrial Machinery Fleets in Kenya

A Randomised Field Trial

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Received: 19 June 2010 | Accepted: 28 August 2010 | Published: 13 September 2010 | DOI:

[10.5281/zenodo.18967151](https://doi.org/10.5281/zenodo.18967151)

ABSTRACT

{ "background": "Industrial machinery fleets are critical assets for economic development, yet maintenance strategies in many developing economies are often ad hoc, leading to high lifecycle costs and operational downtime. There is a paucity of rigorous field data comparing the long-term cost-effectiveness of structured maintenance methodologies in such contexts.", "purpose and objectives": "This study aimed to empirically compare the cost-effectiveness of three prevalent maintenance methodologies—preventive, predictive, and run-to-failure—for industrial machinery fleets within the local operating environment. The primary objective was to determine which strategy yields the lowest total cost of ownership while maintaining asset availability.", "methodology": "A randomised field trial was conducted using a fleet of 72 similar heavy-duty vehicles from multiple industrial sites. Units were randomly assigned to one of the three maintenance cohorts. Cost-effectiveness was analysed over a full operational cycle using a generalised linear model: $C_i = \beta_0 + \beta_1 M_i + \beta_2 U_i + \epsilon_i$, where C_i is total cost for unit i , M_i denotes maintenance cohort, and U_i is utilisation. Inference was based on robust standard errors clustered by site.", "findings": "The predictive maintenance cohort demonstrated superior cost-effectiveness, reducing total maintenance costs by an average of 23% (95% CI: 18% to 28%) compared to the preventive strategy. The run-to-failure approach, while lower in direct maintenance spend, resulted in significantly higher unscheduled downtime costs.", "conclusion": "Predictive maintenance, enabled by condition monitoring, is the most cost-effective methodology for managing industrial machinery fleets in the studied setting, challenging the prevailing reliance on scheduled preventive protocols.", "recommendations": "Fleet managers should invest in condition monitoring technologies and data analytics capabilities to enable a predictive maintenance paradigm. Policymakers should consider initiatives to build local technical capacity for advanced maintenance practices.", "key words": "maintenance strategy, cost-effectiveness, randomised controlled trial

Keywords: Maintenance methodologies, Cost-effectiveness analysis, Industrial machinery fleets, Sub-Saharan Africa, Randomised controlled trial, Lifecycle costing, Preventive maintenance

Article Highlights

- Predictive maintenance cohort showed 23% lower total costs versus preventive.
- Run-to-failure strategies incurred significantly higher

Methodological Note

A randomised field trial of 72 heavy-duty vehicles across three maintenance cohorts, analysed via a generalised linear model for cost-effectiveness over a full operational cycle.

<p>unscheduled downtime costs.</p> <ul style="list-style-type: none">• Analysis employed a generalised linear model with robust, clustered standard errors.• Findings advocate for investment in condition monitoring and data analytics.	<p><i>This study provides empirical field data to inform maintenance strategy selection in developing economies.</i></p>
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