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Replication and Methodological Evaluation of a Bayesian Hierarchical Model for the Cost-Effectiveness of Industrial Machinery Fleets in Kenya

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ABSTRACT

Background: The optimisation of capital-intensive industrial machinery fleets is a critical engineering management challenge in developing economies. A previously proposed Bayesian hierarchical model offered a novel framework for evaluating the cost-effectiveness of such fleets, but its methodological robustness and applicability in a real-world context required independent verification.

Purpose and objectives: This study aimed to replicate and methodologically evaluate the published Bayesian hierarchical model for machinery fleet cost-effectiveness. The primary objective was to assess the model's computational reproducibility, sensitivity to prior specifications, and the stability of its inferences when applied to operational data from Kenya.

Keywords: *Replication study, Bayesian hierarchical modelling, Cost-effectiveness analysis, Industrial machinery fleets, Sub-Saharan Africa*

Article Highlights

- Computational reproducibility of a Bayesian hierarchical model was successfully assessed.
- Sensitivity analyses showed a 40% widening of credible intervals under alternative priors.
- Original conclusions were found to be moderately dependent on prior assumptions.
- The study underscores the need for methodological transparency in engineering economics.

Core Model Specification

Replicated model: $y_{ij} \sim \text{Normal}(\mu + \alpha_i + \beta_j, \sigma^2)$, with $\alpha_i \sim \text{Normal}(0, \tau_\alpha)$ and $\beta_j \sim \text{Normal}(0, \tau_\beta)$.

This replication study evaluates methodological robustness rather than presenting new empirical findings.

ABSTRACT-ONLY PUBLICATION

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

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