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WORKING PAPER

A Bayesian Hierarchical Model for the Cost-Effectiveness of Industrial Machinery Fleets in Ethiopia

A Methodological Evaluation

Selamawit Tesfaye[1,2] | **Abebe Mekonnen**[2]
Yonas Tadesse[2,3]

1 *Ethiopian Public Health Institute (EPHI)*
2 *Hawassa University*
3 *Mekelle University*

Correspondence: stesfaye@gmail.com

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ABSTRACT

Background: The assessment of cost-effectiveness for industrial machinery fleets in developing economies is often hampered by sparse, heterogeneous data and the need to integrate operational parameters with economic constraints. Existing deterministic models frequently fail to quantify the uncertainty inherent in such complex engineering systems.

Purpose and objectives: This working paper presents a methodological evaluation of a novel Bayesian hierarchical model designed to rigorously measure the cost-effectiveness of industrial machinery fleets. The objective is to provide a robust framework that quantifies uncertainty and pools information across disparate fleet units.

Keywords: *Bayesian hierarchical modelling, cost-effectiveness analysis, industrial machinery fleets, Sub-Saharan Africa, developing economies, maintenance optimisation*

Article Highlights

- Three-level hierarchical model shrinks extreme estimates toward group mean
- Quantifies uncertainty in cost-effectiveness ratios for fragmented data
- Superior precision compared to conventional deterministic approaches
- Framework supports asset management and procurement planning

Methodological Contribution

A Bayesian hierarchical model that formally incorporates uncertainty and improves estimation efficiency through partial pooling of heterogeneous fleet data.

This paper presents a methodological framework, not an empirical case study.