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Bayesian Hierarchical Model for Assessing Cost-Effectiveness of Manufacturing Plants in South Africa: A Methodological Evaluation

Nomiwezi Masego[1]

[1] Department of Research, SA Medical Research Council (SAMRC)

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Correspondence: nmasego@yahoo.com

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Author notes

Nomiwezi Masego is affiliated with Department of Research, SA Medical Research Council (SAMRC) and focuses on Environmental Science research in Africa.

Abstract

The cost-effectiveness of manufacturing plants is crucial for environmental sustainability and economic viability in South Africa. A Bayesian hierarchical model was developed to analyse data from multiple manufacturing plants. The model accounts for variability within and between plants by incorporating random effects that capture plant-specific characteristics such as size, technology type, and operational practices. The analysis revealed significant differences in cost-effectiveness across different sectors and plant sizes, with a particular emphasis on smaller-scale operations showing greater potential for cost optimization. The Bayesian hierarchical model provided insights into the complex interplay of factors affecting manufacturing costs, offering a nuanced understanding that can guide future policy and investment decisions. Manufacturing plants in South Africa should prioritise technologies and operational practices that align with the identified best practices from the analysis. Policy makers could also consider incentives for smaller-scale operations to promote cost-effective solutions. Bayesian hierarchical model, manufacturing plant costs, environmental science, South Africa The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *South Africa, Bayesian hierarchical model, cost-effectiveness analysis, manufacturing systems, environmental sustainability, econometric methods, stochastic modelling*

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