Bayesian Hierarchical Model for Measuring Efficiency Gains in South African Manufacturing Plants Systems

Siyabonga Maluleke[1], **Khudumiso Dlamini**[2], **Xolile Mkhize**[2,3]

[1] Department of Civil Engineering, Human Sciences Research Council (HSRC)

[2] Human Sciences Research Council (HSRC)

[3] Department of Electrical Engineering, University of the Witwatersrand

Author notes

Siyabonga Maluleke is affiliated with Department of Civil Engineering, Human Sciences Research Council (HSRC) and focuses on Engineering research in Africa.

Khudumiso Dlamini is affiliated with Human Sciences Research Council (HSRC) and focuses on Engineering research in Africa.

Xolile Mkhize is affiliated with Human Sciences Research Council (HSRC) and focuses on Engineering research in Africa.

Abstract

Recent studies have highlighted the need for more sophisticated methodologies to assess efficiency gains in South African manufacturing plants. A Bayesian hierarchical model was employed to analyse data from several manufacturing plants across South Africa, allowing for the estimation of both overall plant efficiencies and individual process efficiencies while accounting for potential heterogeneity between different sites. The analysis revealed significant gains in efficiency ranging from a 15% to 20%, with notable improvements observed in resource utilization and production output. This study demonstrates the effectiveness of Bayesian hierarchical models in quantifying efficiency gains across diverse manufacturing environments, providing empirical evidence for their utility. The findings suggest that further research should focus on validating these methodologies against other existing models to ensure broader applicability. The maintenance outcome was modelled as $Y\{\} = beta\,0 + beta\,1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *South Africa, Bayesian Statistics, Hierarchical Modelling, Econometrics, Efficiency Analysis, Manufacturing Systems, Quality Control*

ABSTRACT-ONLY PUBLICATION

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

✉ REQUEST FULL PAPER

Email: info@parj.africa

Request your copy of the full paper today!

SUBMIT YOUR RESEARCH

Are you a researcher in Africa? We welcome your submissions!

Join our community of African scholars and share your groundbreaking work.

Submit at: app.parj.africa

Scan to visit app.parj.africa

Open Access Scholarship from PARJ

Empowering African Research | Advancing Global Knowledge