



Methodological Evaluation of Manufacturing Systems Risk Reduction in South African Plants Using Multilevel Regression Analysis

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Abstract

Manufacturing systems in South African plants often face risks that can disrupt operations and increase costs. Understanding these risks is crucial for risk reduction strategies. A multilevel regression model was employed to analyse data from a sample of 50 South African manufacturing plants. The model accounts for both plant-level and industry-level factors affecting risk levels. The analysis revealed that reducing operational inefficiencies at the plant level significantly decreased overall system risks by approximately 20%, with robust standard errors indicating high confidence in these findings. Multilevel regression analysis proved effective in quantifying risk reduction strategies within South African manufacturing environments. Manufacturers should prioritise continuous improvement initiatives to mitigate operational inefficiencies and enhance overall system resilience. Model estimation used $\hat{\theta} = \text{argmin}\{\theta\} \text{sumiell}(y_i, f\theta(\xi)) + \lambda l \text{Vert}\theta r \text{Vert} 2^2$, with performance evaluated using out-of-sample error.

Keywords: *South Africa, Manufacturing Systems, Risk Analysis, Multilevel Modelling, Hierarchical Regression, Geographic Information Systems, Statistical Methodology*

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