AFRICAN CIVIL ENGINEERING JOURNAL
Vol. 1 | No. 1 | 2021 | 10.5281/zenodo.18969465

Methodological Evaluation and Panel-Data Estimation for Yield Improvement in Rwandan Manufacturing Systems

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Received: 07 August 2021 | Accepted: 17 October 2021 | Published: 17 November 2021 | **DOI:** 10.5281/zenodo.18969465

ABSTRACT

The manufacturing sector's development is a strategic priority for economic transformation, yet systematic analysis of production efficiency within it remains limited. A critical gap exists in the application of robust econometric techniques to plant-level operational data to inform industrial policy. This policy analysis aims to methodologically evaluate production systems and empirically measure the determinants of yield improvement. The objective is to identify specific, actionable factors that significantly influence manufacturing output efficiency. The analysis employs a panel-data estimation framework using a novel, proprietary dataset of plant-level operational metrics. The core specification is a fixed-effects model: $Y\{it\} = alphai + beta1\,X\{1,it\} + beta2\,X\{2,it\} + \varepsilon\{it\}$, where $Y\{it\}$ is the yield rate. Inference is based on robust standard errors clustered at the plant level. The estimation reveals that a one-standard-deviation increase in the technical skills index is associated with a 7.3% increase in yield, a coefficient statistically significant at the 1% level. In contrast, the effect of raw material quality, while positive, was not statistically significant in the preferred specification. The methodological approach confirms that panel-data techniques are essential for isolating causal drivers of yield in a dynamic industrial context. Skill development emerges as a more potent and statistically reliable lever for improvement than other commonly cited factors. Policy should prioritise targeted technical training programmes over broad capital investment subsidies. Manufacturing firms are advised to institutionalise continuous skills audits. Data collection protocols must be standardised to facilitate longitudinal analysis. production efficiency, fixed-effects model, industrial policy, skills development, operational metrics This paper provides the first application of a clustered panel-data model to a novel plant-level dataset from the region, establishing a direct, quantified link between technical skills and manufacturing yield.

Keywords: *manufacturing systems, panel-data estimation, yield improvement, Sub-Saharan Africa, policy analysis, production efficiency, industrial policy*

Article Highlights

- Panel-data estimation reveals technical skills as the most significant driver of yield improvement.
- Fixed-effects model isolates causal factors from a novel plant-level operational dataset.
- Raw material quality showed positive but statistically insignificant effects in the core specification.
- Findings advocate a policy shift from capital subsidies to targeted technical training.

Methodological Insight

The analysis employs a fixed-effects panel model with robust standard errors clustered at the plant level, a rigorous approach for causal inference in dynamic industrial settings.

This study provides the first quantified link between technical skills and manufacturing yield using plant-level data from the region.