



# Methodological Evaluation of Process-Control Systems in Nigerian Oil Refineries Using Multilevel Regression Analysis for Cost-Effectiveness Assessment

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## Abstract

Process-control systems (PCS) are critical for ensuring efficiency and safety in oil refineries. However, their implementation costs can vary significantly across different facilities in Nigeria. PCS data from 15 Nigerian refineries were analysed. Multilevel regression models, accounting for both fixed effects (facilities) and random effects (operational practices), were applied to assess cost-effectiveness. The analysis revealed that facilities with higher operational complexity had significantly higher PCS implementation costs, though the exact proportion is not specified. Multilevel regression provided insights into the drivers of cost differences among Nigerian refineries, enhancing understanding for future investments in PCS. Facilities should consider their operational context when planning PCS investments to optimise costs and benefits. PCS, Cost-effectiveness, Multilevel Regression, Nigeria, Oil Refineries The maintenance outcome was modelled as  $Y = \beta_0 + \beta_1 X + u_i + v + \epsilon$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** Nigerian, multilevel, regression, cost-effectiveness, automation, engineering, control systems

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