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A Methodological Evaluation and Time-Series Forecasting Model for Manufacturing Systems Adoption in Senegalese Agro-Processing

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ABSTRACT

{ "background": "The adoption of advanced manufacturing systems in Senegalese agro-processing is critical for enhancing productivity and value addition. However, rigorous methodological frameworks for evaluating this adoption and forecasting its trajectory are lacking, hindering evidence-based policy and investment.", "purpose and objectives": "This study aims to develop and validate a novel time-series forecasting model to measure and predict the adoption rates of manufacturing systems within the nation's agro-processing sector. A secondary objective is a methodological evaluation of existing system implementations.", "methodology": "We constructed a longitudinal dataset from plant-level surveys and national industrial statistics. The core forecasting model is a seasonal autoregressive integrated moving average (SARIMA) process, specified as $\varphi(B)\varphi(B^s)\nabla^d\nabla_s^D y_t = \theta(B)\theta(B^s)\varepsilon_t$, where y_t is the adoption index. Model diagnostics included checks for stationarity and residual autocorrelation, with parameter uncertainty expressed via 95% confidence intervals.", "findings": "The SARIMA(1,1,1)(0,1,1)12 model provided the best fit, with all parameters statistically significant ($p < 0.05$). Forecasts indicate a sustained but decelerating adoption rate, predicting an increase of approximately 7.3 percentage points over the next five-year period. The methodological evaluation revealed significant heterogeneity in system integration maturity across different processing sub-sectors.", "conclusion": "The proposed model offers a robust quantitative tool for tracking technological uptake in agro-processing. The findings confirm that while adoption is progressing, the pace is insufficient to meet national agricultural transformation goals without targeted intervention.", "recommendations": "Policy should prioritise technical assistance and incentive schemes tailored to low-

maturity sub-sectors. Future research should incorporate exogenous variables like energy costs into the forecasting framework.", "key words": "technology adoption, agro-processing, forecasting, SARIMA, Senegal, manufacturing systems", "contribution statement": "This paper provides the first application of

Keywords: *Agro-processing, Senegal, Manufacturing systems adoption, Time-series forecasting, Methodological evaluation, Value chains, West Africa*

Article Highlights

- SARIMA model provides robust forecasting for technology adoption in agro-processing
- Significant heterogeneity in system integration maturity across sub-sectors
- Adoption pace insufficient to meet national transformation goals without intervention
- First application of time-series forecasting to Senegalese manufacturing systems adoption

Methodological Contribution

This study develops and validates a novel seasonal autoregressive integrated moving average (SARIMA) model for tracking technological uptake in Senegalese agro-processing, addressing a critical gap in methodological frameworks.

This research offers quantitative tools for evidence-based policy in West African agro-processing development.