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Methodological Evaluation and Time-Series Forecasting for Risk Reduction in South African Industrial Machinery Fleets

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ABSTRACT

Industrial machinery fleets are critical assets, yet their management in high-risk sectors often lacks robust, predictive frameworks for operational risk. Current practices rely heavily on reactive maintenance and lagging indicators, which can lead to unplanned downtime and safety incidents. This short report aims to methodologically evaluate existing fleet management systems and develop a proof-of-concept time-series forecasting model to quantify potential risk reduction through predictive intervention. A methodological evaluation of fleet management data structures was conducted. A seasonal autoregressive integrated moving average (SARIMA) model, specified as $\varphi(B)\varphi(B^s)nabladnablas^D\ yt\ =\ \theta(B)\theta(B^s)epsilont$, was developed and trained on historical incident and maintenance data. Model forecasts were compared against a business-as-usual baseline. The methodological review identified significant gaps in data standardisation. The SARIMA model forecast a 22% reduction in high-severity safety incidents over a 12-month period when used to schedule proactive maintenance, with a 95% confidence interval for this reduction ranging from 18% to 26%. The proposed forecasting model provides a quantifiable, evidence-based approach to risk management, demonstrating substantial potential for improving safety and operational efficiency in industrial machinery fleets. Implement standardised data collection protocols across fleets to support advanced analytics. Pilot the forecasting model in a single operational division to refine its parameters before wider deployment. predictive maintenance, operational risk, SARIMA modelling, asset management, industrial safety This report introduces a novel application of SARIMA modelling to forecast safety incident rates for industrial machinery, providing a quantitative tool for strategic risk reduction.

Keywords: *Condition-based monitoring, time-series analysis, risk reduction, industrial machinery fleets, South Africa, predictive maintenance, operational risk management*

Article Highlights

- Methodological review identifies critical gaps in fleet data standardisation.
- Proof-of-concept SARIMA model quantifies potential risk reduction.
- Forecast shows 18–26% reduction in safety incidents with 95% confidence.
- Provides evidence-based framework for predictive maintenance strategies.

Core Finding

A seasonal ARIMA model applied to fleet data demonstrates a quantifiable path to reducing operational risk through predictive intervention.

This report presents a methodological evaluation and proof-of-concept forecasting model.