

INTISARI

PENDEKATAN HIBRIDA *MULTIPLICATIVE HOLT-WINTER* DAN *LONG SHORT-TERM MEMORY*: MENINGKATKAN PERFORMA PREDIKSI PENJUALAN

Oleh

Merisa Adha Azzahra

23/530077/PPA/06711

Peramalan (*forecasting*) merupakan proses memprediksi kejadian di masa depan berdasarkan data historis dan memiliki peran penting dalam pengambilan keputusan bisnis. Akurasi menjadi faktor kunci karena peningkatan kecil dalam hasil prediksi dapat berdampak signifikan terhadap profit dan efisiensi operasional. Namun, pada data deret waktu musiman yang fluktuatif dan nonlinier, metode statistik tunggal maupun model *deep learning* sering kali kurang optimal dalam menangkap keseluruhan pola data. Oleh karena itu, penelitian ini bertujuan untuk meningkatkan akurasi peramalan dengan mengembangkan model *hybrid* yang mampu memadukan keunggulan kedua pendekatan tersebut.

Model *hybrid* dirancang dengan mengombinasikan metode *Multiplicative Holt-Winters* dan *Long Short-Term Memory (LSTM)* secara *parallel-series*, di mana *output* Holt-Winters digunakan sebagai *input* untuk LSTM. Data yang digunakan terdiri dari tiga dataset musiman, yaitu *Kenyan E-commerce Sales Data*, *Online Retail*, dan *Daily Demand*, yang masing-masing berisi catatan penjualan harian dengan jumlah data berbeda. Tahapan pengolahan meliputi penanganan nilai hilang, transformasi tanggal, normalisasi, pembentukan *input-output sequence*, serta pemisahan data latih dan uji. Evaluasi kinerja model dilakukan menggunakan metrik *Mean Absolute Percentage Error (MAPE)* dan *Root Mean Squared Error (RMSE)*.

Hasil eksperimen menunjukkan bahwa model *hybrid* menghasilkan nilai MAPE terendah sebesar 0,0370 dan RMSE terendah sebesar 18.980,5732, yang lebih baik dibandingkan model tunggal pada seluruh dataset. Temuan ini membuktikan bahwa kombinasi metode statistik dan *deep learning* mampu meningkatkan akurasi serta stabilitas prediksi pada data deret waktu musiman dengan pola fluktuatif, sehingga dapat menjadi alternatif solusi dalam pengambilan keputusan berbasis data yang lebih andal.

Kata Kunci: *Forecasting*, *Holt-Winters Multiplicative*, *LSTM*, Pendekatan Hibrida

ABSTRACT

A HYBRID APPROACH OF MULTIPLICATIVE HOLT-WINTER AND LONG SHORT-TERM MEMORY: IMPROVING SALES PREDICTION PERFORMANCE

By

Merisa Adha Azzahra

23/530077/PPA/06711

Forecasting is the process of predicting future events based on historical data and plays a crucial role in business decision-making. Accuracy is key because small improvements in prediction results can significantly impact profitability and operational efficiency. However, with fluctuating and non-linear seasonal data, single statistical methods and deep learning models are often less than optimal in capturing the full data pattern. Therefore, this study aims to improve forecasting accuracy by developing a hybrid model that combines the advantages of both approaches.

The hybrid model is designed by combining the Multiplicative Holt-Winters and Long Short-Term Memory (LSTM) methods in a parallel-series manner, with the Holt-Winters output used as input for the LSTM. The data used consists of three seasonal datasets: Kenya Ecommerce Sales Data, Online Retail, and Daily Demand, each containing daily sales records with varying amounts of data. The processing steps include handling missing values, date transformation, normalization, generating input-output sequences, and verifying training and test data. Model performance evaluation was conducted using the Mean Absolute Percentage Error (MAPE) and Root Mean Squared Error (RMSE) metrics.

Experimental results showed that the hybrid model produced the lowest MAPE value of 0.0370 and the lowest RMSE of 18,980.5732, which was superior to the single model across all datasets. These findings demonstrate that the combination of statistical and deep learning methods can improve the accuracy and stability of predictions on seasonal time series data with fluctuating patterns, thus offering an alternative solution for more reliable data-driven decision-making.

Keywords: Forecasting, Holt-Winters Multiplicative, LSTM, Hybrid Approach