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**APPLYING TEMPORAL FUSION  
TRANSFORMERS FOR  
AIR QUALITY FORECASTING  
IN METRO MANILA**

# WHY THIS MATTER?

Air quality forecasting is vital for reducing health risks and supporting urban planning, especially in rapidly urbanizing regions like Metro Manila where pollution levels fluctuate with traffic, weather, and seasonal changes. Traditional models such as ARIMA and LSTM struggle with multivariate, irregular, and long-horizon time-series data, limiting their effectiveness. The Temporal Fusion Transformer (TFT), introduced by Lim and Arik (2019), addresses these challenges by combining recurrent layers, attention mechanisms, and gating to deliver accurate, interpretable multi-horizon forecasts. Leveraging self-attention, this Transformer-based approach captures complex temporal patterns and cross-variable relationships, making it particularly well-suited for forecasting critical pollutants like PM<sub>2.5</sub> in dynamic urban environments.



# EXPERIMENTAL RESULT

## OVERALL PERFORMANCE

- MAE: 0.513  $\mu\text{g}/\text{m}^3$
- RMSE: 0.618  $\mu\text{g}/\text{m}^3$
- $R^2$ : 0.9975

## DAY-WISE ACCURACY (1–7 DAYS):

- Days 1–6: MAE < 0.52  $\mu\text{g}/\text{m}^3$  (excellent short-term forecasts).
- Day 7: MAE = 0.83  $\mu\text{g}/\text{m}^3$  (still strong for long-term).
- All days:  $R^2 > 0.97$

Day	MAE ( $\mu\text{g}/\text{m}^3$ )	RMSE ( $\mu\text{g}/\text{m}^3$ )	$R^2$
1	0.4630	0.5514	0.9971
2	0.3760	0.4291	0.9951
3	0.4203	0.4435	0.9751
4	0.5125	0.6051	0.9735
5	0.4867	0.6428	0.9978
6	0.5047	0.5541	0.9988
7	0.8276	0.9501	0.9953



**THIS  
MEANS**

**LOW ERROR**

**(MAE 0.513 MG/M<sup>3</sup>, R<sup>2</sup> = 0.9975)**

This means the model is very accurate, almost matching real PM2.5 levels. In terms of air quality, this is good because we can trust the forecasts.

# **PROBABILISTIC FORECASTS (WITH UNCERTAINTY RANGES)**

**Instead of one rigid prediction, TFT gives a range of possible outcomes. This is good for air quality management because policymakers can plan for both normal and worst-case pollution days.**





# HEALTH & POLICY IMPLICATION

Accurate 7-day forecasts = early warnings for bad air days. This is good because it helps people (especially those with asthma/respiratory illness) take precautions and helps government issue advisories.

# IMPACTS AND BENEFITS



Enhanced Forecasting Accuracy and Interpretability



Robustness in Real-World Conditions



Policy-Relevant Probabilistic Forecasting



Scalability and Generalizability



# CONCLUSION

The Temporal Fusion Transformer (TFT) proved highly effective for air quality forecasting in Metro Manila, achieving outstanding accuracy (MAE:  $0.513 \mu\text{g}/\text{m}^3$ ,  $R^2$ : 0.9975) across 7-day horizons while offering interpretable insights into pollution drivers. By handling multivariate inputs, long-term dependencies, and real-world data irregularities, the model outperformed traditional methods like ARIMA and LSTM. Its probabilistic forecasts support risk-aware public health decisions, and its interpretability empowers evidence-based policymaking. These strengths make TFT a strong candidate for real-world deployment in environmental monitoring systems, laying the groundwork for AI-driven environmental management and more sustainable, resilient urban planning in the Philippines.

# THANK YOU FOR LISTENING

Temporal Fusion Transformers deliver accurate, interpretable, and actionable air quality forecasts, paving the way for smarter, healthier, and more resilient cities.