

**PEMODELAN SPASIAL KEMISKINAN MIKRO BERBASIS *GRAPH CONVOLUTIONAL NETWORKS* PADA TOPOLOGI JARINGAN JALAN
KOTA JAKARTA PUSAT**

Oleh:

Ananda Shabrina Putri Gunawan

NIM. 22/505172/GE/10055

INTISARI

Kemiskinan mikro di wilayah perkotaan sering kali tidak teridentifikasi secara akurat akibat bias agregasi spasial (*Modifiable Areal Unit Problem/MAUP*) dan keterbatasan pendekatan jarak Euclidean dalam merepresentasikan aksesibilitas aktual. Penelitian ini mengembangkan model estimasi kemiskinan mikro berbasis *Spectral Graph Convolutional Networks* (GCN) dengan merepresentasikan jaringan jalan Kota Jakarta Pusat sebagai graf yang dibangun dari data OpenStreetMap, menggunakan titik geolokasi penerima Program Keluarga Harapan (PKH) sebagai data acuan. Model dilatih melalui strategi *two-stage training* berbasis *Graph Autoencoder* dan dibandingkan dengan model *Random Forest* berbasis fitur Euclidean. Studi ablasi menunjukkan bahwa informasi topologi jaringan jalan berperan penting dalam meningkatkan kemampuan model mengestimasi kerentanan. Meskipun *Random Forest* menunjukkan akurasi agregat yang lebih tinggi, GCN menghasilkan konsistensi spasial yang lebih baik melalui mekanisme *message passing* yang mempertahankan keterkaitan antarsimpul pada jaringan jalan. Dekomposisi varians menunjukkan bahwa 31,55% keragaman kerentanan terjadi di dalam kelurahan, sehingga tidak dapat dijelaskan oleh pendekatan agregat administratif. Analisis *Global Moran's I* menunjukkan adanya autokorelasi spasial positif yang sangat kuat pada hasil prediksi, sedangkan analisis *Local Indicators of Spatial Association* (LISA) mengonfirmasi pembentukan kluster *High-High* dan *Low-Low* yang mengikuti pola keterhubungan pada jaringan jalan. Interpretasi SHAP menunjukkan bahwa fitur isolasi topologis memberikan kontribusi terbesar terhadap prediksi. Peta kerentanan beresolusi simpul

jalan yang dihasilkan berpotensi mendukung identifikasi klaster kerentanan sosial-ekonomi serta penargetan bantuan sosial yang lebih presisi.

Kata kunci: kemiskinan mikro, *Graph Convolutional Networks*, topologi jaringan jalan, MAUP, *Explainable AI*, Jakarta Pusat.

***SPATIAL MODELING OF MICRO-POVERTY USING GRAPH
CONVOLUTIONAL NETWORKS ON ROAD NETWORK TOPOLOGY IN
CENTRAL JAKARTA***

By:

Ananda Shabrina Putri Gunawan

NIM. 22/505172/GE/10055

ABSTRACT

Urban micro-poverty is often inadequately identified due to spatial aggregation bias, known as the Modifiable Areal Unit Problem (MAUP), and the limitations of Euclidean distance-based approaches in representing actual accessibility. This study develops a micro-poverty estimation model based on Spectral Graph Convolutional Networks (GCN) by representing the road network of Central Jakarta as a graph constructed from OpenStreetMap data, using geolocated beneficiaries of the Family Hope Program (Program Keluarga Harapan/PKH) as reference data. The model was trained using a two-stage Graph Autoencoder-based strategy and compared with a Random Forest model based on Euclidean features. Ablation analysis demonstrated that road network topology plays an important role in improving the model's ability to estimate vulnerability. Although the Random Forest model achieved higher aggregate accuracy, the GCN model exhibited better spatial consistency through a message-passing mechanism that preserves inter-node dependencies within the road network. Variance decomposition revealed that 31.55% of vulnerability variation occurred within administrative villages, indicating that a substantial proportion of micro-level heterogeneity cannot be explained by aggregated administrative approaches. Global Moran's I analysis indicated a very strong positive spatial autocorrelation in the predicted vulnerability patterns, while Local Indicators of Spatial Association (LISA) confirmed the presence of High–High and Low–Low clusters that followed the connectivity structure of the road network. SHAP interpretation

further showed that topological isolation features contributed most substantially to the predictions. The resulting road-node-resolution vulnerability map has the potential to support the identification of socio-economic vulnerability clusters and more precise targeting of social assistance programs.

Keywords: *micro-poverty, Graph Convolutional Networks, road network topology, MAUP, Explainable AI, Central Jakarta.*