

Spatial Decision Support in Transitional Cities: Integrating Machine Learning and GIS-MCDA to Assess Housing Price Dynamics

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Abstract Property valuation is a crucial lens for interpreting urban transformation, offering insights that support both policy-making and market forecasting. Understanding the dynamics of real estate markets in transitional cities requires advanced approaches that go beyond traditional models, which often fall short in capturing spatial-temporal complexity. This study proposes a hybrid methodological framework that combines machine learning (ML) and spatial econometrics within a Geographic Information System (GIS) environment to reveal spatial patterns in property values and support evidence-based urban decision-making.

The methodology combines statistical modelling, spatial analysis, and an indicator-based approach to develop a Spatial Decision Support System (SDSS), aimed at supporting policy-makers through structured, multi-dimensional, and spatial-temporal assessments of housing market dynamics. It leverages advanced techniques such as the Least Absolute Shrinkage and Selection Operator (LASSO) for variable selection and forecasting, and GIS-based Multi-Criteria Decision Analysis (GIS-MCDA) method to prioritise valuation criteria.

The case study of Rotterdam, The Netherlands, tests the methodology and investigates how short- and long-term housing markets interact across space and time. LASSO regression, applied in R, identifies key predictors of property prices, which are then aggregated using the TOPSIS method in a GIS environment to generate a composite index capturing multi-dimensional dynamics such as spatial value shifts, income distribution, and market intensity.

Spatial outputs generated in GIS provide visualisations of housing value trends, highlighting the city's main axes of residential development and areas affected by tourism-induced urban pressures. The resulting SDSS offers an adaptable interface for urban planning under uncertainty, particularly in addressing gentrification, displacement, and equitable housing access.

This research contributes a replicable methodology for analysing property market dynamics in transitional cities. By bridging data-driven analysis with spatial decision support, it delivers practical insights for decision-makers involved in climate-neutral and socially inclusive urban development.