Multi-City Analysis of AirBnB Markets: Key Determinants, Dynamics, Value, and Predictive Modelling with Machine Learning

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This study analyzes key determinants of AirBnB listing prices across eleven major cities using machine learning algorithms by developing predictive models. The work will further analyze the dynamics of markets in relation to the value assessment of cities so as to optimize pricing strategies to enhance booking experiences for both hosts and travellers.

01. INTRODUCTION

Airbnb revolutionized hospitality by enabling hosts to rent spaces, but pricing optimization remains a challenge [1]. While this offers travelers diverse and affordable options, it also presents challenges in price optimization and value assessment. Existing pricing tools, such as "Smart Pricing," lack the granularity needed for personalized strategies, making it difficult for hosts to set competitive rates [2]. Additionally, travelers struggle to assess listings due to pricing variability and inconsistent amenities. To enhance Airbnb's global expansion, more accurate, context-sensitive pricing models are needed, incorporating local demand trends and urban complexities [3].

02. RESEARCH QUESTIONS

1. What are the most influential factors affecting AirBnB listing prices, and which machine learning model performs best: CatBoost, Random Forest, or Neural Networks?
2. Which are the biggest differences in market characteristics in terms of Airbnb across the eleven cities?
2.a. Which city offers the best value for travellers?

03. RESEARCH APPROACH

Research Design:

- Quantitative Analysis: Focus on statistical and machine learning techniques.
- Descriptive and Exploratory: Describe Airbnb listing features and market trends; explore key pricing factors and emerging patterns.

Data Collection and Tools:

- Dataset: Airbnb Listings and Reviews from Inside Airbnb (over 60,000 listings across eleven major cities- data as of July 2024).
  - https://insideAirBnB.com/get-the-data/

Tools: Python for data processing and machine learning; Tableau for visualizations.

04. DATA ANALYSIS

Data Cleaning and Preprocessing → City-Wise Model Training → EDA (Market Dynamics)

Data Cleaning and Preprocessing	City-Wise Model Training	EDA (Market Dynamics)
Price Standardization	**Manage Skewness and Outliers**	**Compute descriptive statistics**: Mean
Data Cleaning: handled missing values. Retained necessary columns	**Assess feature importance**	**Develop visualizations**: Histograms, box plots, heatmaps, scatter plots in Tableau.
Data normalization: Standardized dataset for consistency.	**Train and test models**: Random Forest, Neural Networks, CatBoost,	**Apply dynamic filters**: Interactive exploration of variables and subsets.
Amenities Transformation: Transformed list to binary columns	**Hyperparameter Tuning**	**Analyze market trends**: Examine trends across cities.
Structure data: Organized necessary fields and categories for effective visualization.	**Cross-Validation**: Evaluated model stability and accuracy.	**Identify patterns**: Analyze visualizations for trends, correlations, and anomalies.
	Compare model performance: Metrics used - RMSE, MAE and R-squared.	

References

[1] 'Morgan Stanley: AirBnB's Threat to Hotels Is Only Getting Sharper', https://www.hospitalityireland.com/hotel/morgan-stanley-AirBnBs-threat-hotels-getting-sharper-34954.
[2] 'Customized Regression Model for AirBnB Dynamic Pricing', https://doi.org/10.1145/3219819.3219830
[3] 'Learning-based AirBnB Price Prediction Model', https://doi.org/10.1109/ECIT52743.2021.00068.

05. RESULTS AND FINDINGS

1. Factors Influencing AirBnB Listing Prices and Model Performance:

Property Attributes

- Accommodates: Larger properties command higher prices.
- Bedrooms: More rooms and amenities increase value.
- Room Type: Entire homes/apartments cost more for privacy.

Host Attributes

- Experience: Longer tenure and larger portfolios increase pricing.
- Engagement: Higher response rates link to premium listings.

Location-Specific Attributes

- Prime Areas: High prices in neighborhoods like Shinjuku (Tokyo), Eixample (Barcelona), and Commercial Triangle (Athens).
- Regulations: Stricter policies (e.g., minimum_nights in Barcelona) influence pricing.

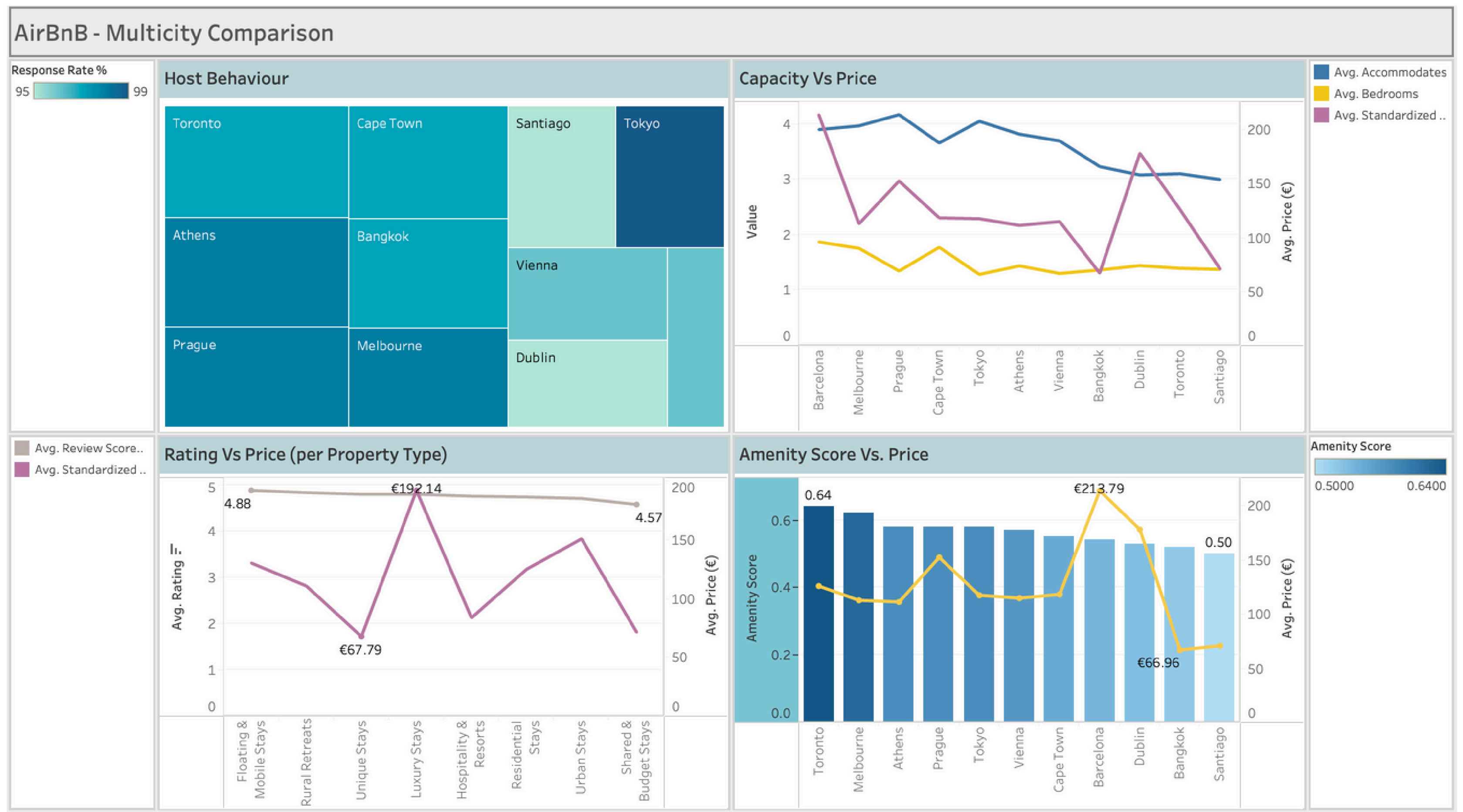
Model Performance:

CatBoost

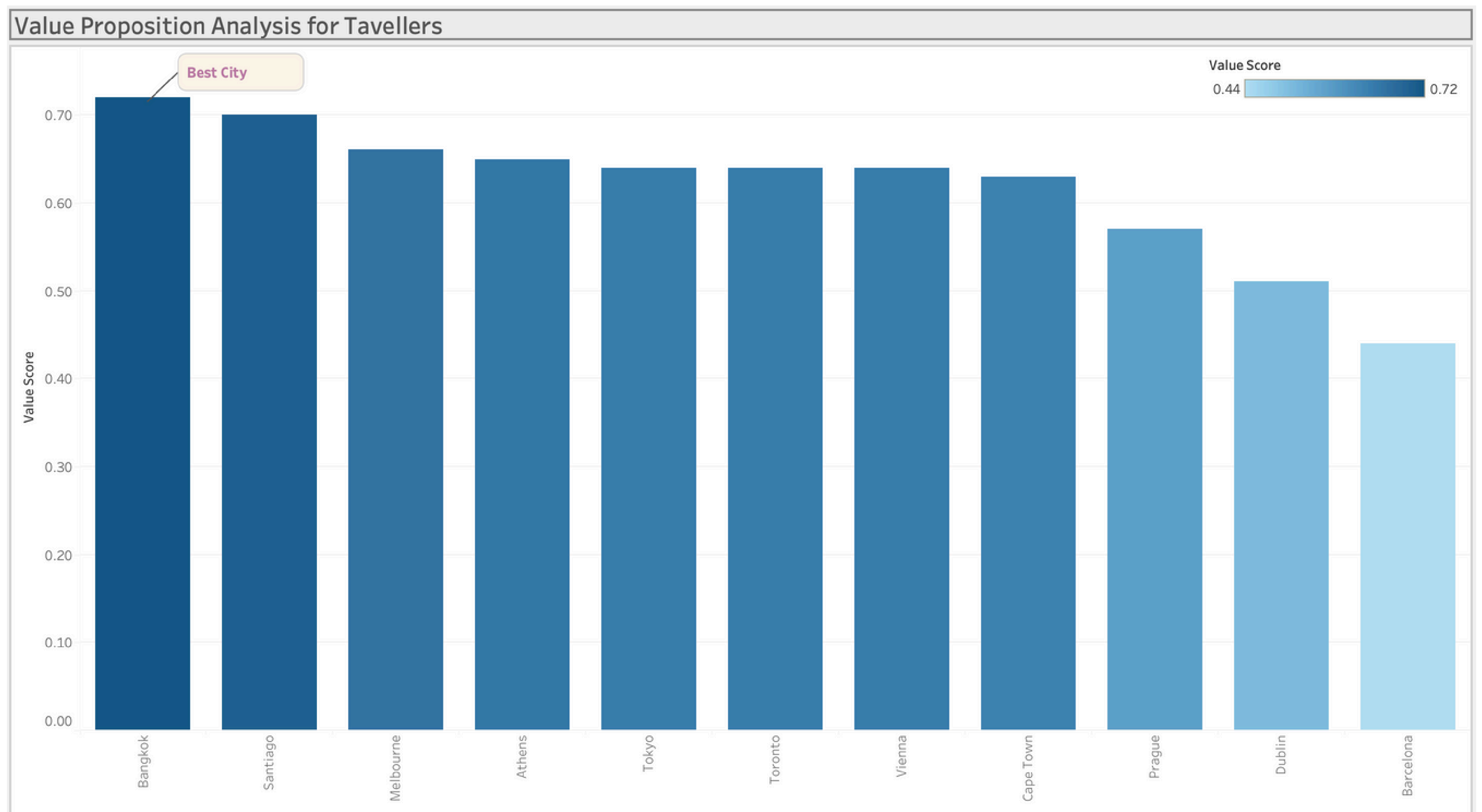
- Best performer with the lowest RMSE and MAE, and the highest R2.
- Excels in handling categorical variables and nonlinear relationships.

Though many factors affecting price were common across the cities, their relative importance and influence varied greatly which is demonstrated by the features for each city.

2. AirBnB Market Trends:



2 a. Best Value City for Travellers:



Toronto

- High Superhost percentages indicate professionalism among hosts.
- Low average listings per host suggest dominance by individual hosts.
- Urban apartments near Downtown Toronto and Waterfront Communities-The Island command premium prices.

Barcelona

- Challenges in host engagement, with low Superhost percentages and acceptance rates.
- Dominated by luxury properties and unique stays appealing to niche travelers.
- Prime neighbourhoods like Eixample and Gothic Quarter command premium prices.

Tokyo

- Very active host community with high response and acceptance rates.
- Central areas like Shinjuku achieve premium prices and strong guest ratings.
- Tourism-focused market with short-term stays and unique accommodations.

Cape Town

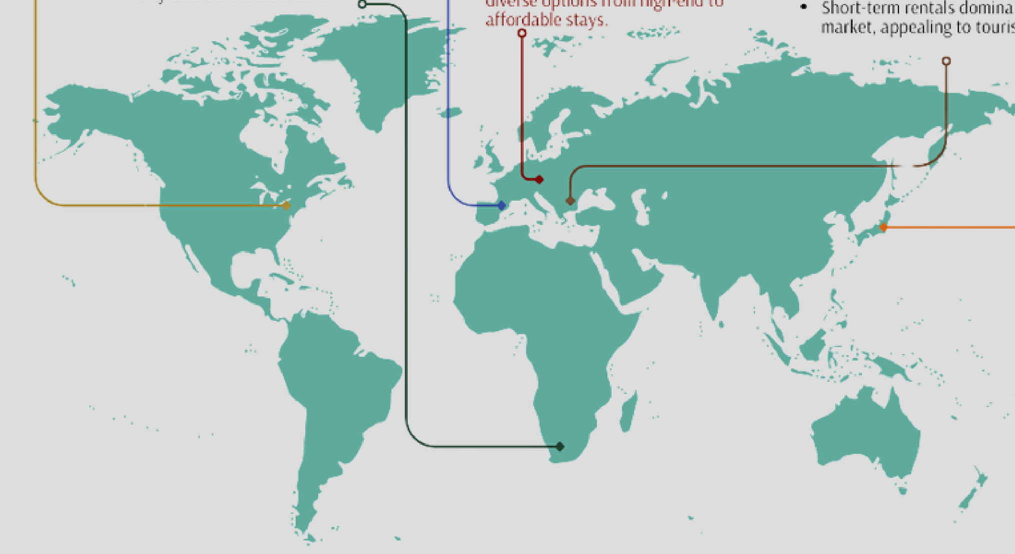
- High amenity scores with a focus on luxury stays (e.g., pools, gyms).
- Premium pricing justified by superior guest experiences and high review scores.
- Top neighbourhoods include Camps Bay and V&A Waterfront.

Prague

- High host activity with excellent response and acceptance rates.
- Combines affordability with high amenity scores, making it a favorite among value-conscious travelers.
- Historic areas like Old Town offer diverse options from high-end to affordable stays.

Athens

- High Superhost engagement, strong response rates, and high acceptance rates.
- Premium pricing near landmarks like Commercial Triangle and Plaka.
- Short-term rentals dominate the market, appealing to tourists.



Santiago

- High-value scores due to affordability paired with guest satisfaction.
- Low average listings per host indicate a market dominated by individual hosts.
- Central neighbourhoods cater to larger groups, offering excellent value and ratings.

Vienna

- Well-rounded market with high amenity scores and diverse accommodations.
- Offers urban apartments, luxury properties, and budget options.
- Central neighbourhoods like Leopoldstadt consistently receive high guest satisfaction ratings.

Melbourne

- Mature market with high average listings per host and many Superhosts.
- Premium destination with common amenities like pools and gyms.
- Family/group accommodations prevalent in areas like Southbank and Docklands.

Dublin

- Low host engagement (Superhost percentages, response, and acceptance rates).
- Urban apartments dominate, catering to short-term tourists.
- High demand near landmarks and city center drives strong ratings and pricing.

Bangkok

- Value leader offering affordability with high guest satisfaction.
- Diverse property types and amenities cater to budget and luxury travelers.
- Tourist hubs like Sukhumvit (Khlong Toei) stand out for competitive pricing and ratings.

06. RECOMMENDATIONS FOR STAKEHOLDERS

For New Hosts

- Set competitive pricing based on local market trends.
- Focus on high-demand neighbourhoods like Shinjuku (Tokyo) or Eixample (Barcelona).
- Prioritize key price drivers like guest capacity and bedrooms; offer essentials.

For Existing Hosts

- Adjust pricing based on demand trends and city-specific factors.
- Upgrade amenities and focus on guest feedback to boost ratings.
- Expand into high-performing neighbourhoods.

For Budget Travellers

- Choose affordable cities like Santiago or Bangkok for value-driven stays.
- Focus on top-rated, budget-friendly neighbourhoods with essential amenities.

For Experience Seekers

- Explore unique stays in Barcelona or luxury in Cape Town.
- Stay in culturally rich areas like Plaka (Athens) or Shinjuku (Tokyo).

For Airbnb Platform

- Enhance dynamic pricing tools with neighbourhood trends and seasonal demand data.
- Add detailed neighbourhood profiles and personalized recommendations.
- Provide city-specific onboarding for new hosts to set competitive strategies.