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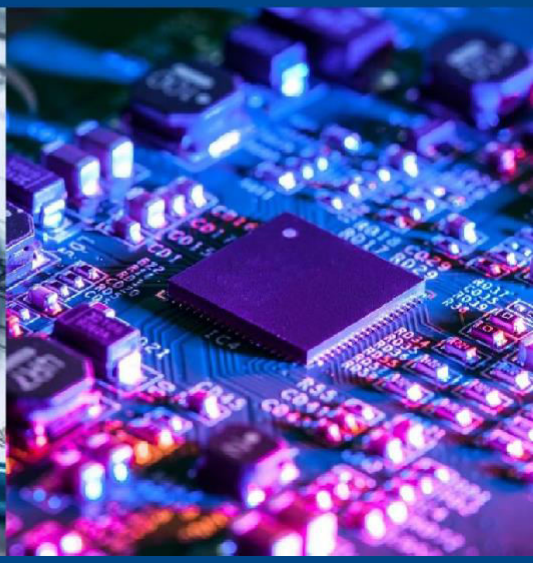

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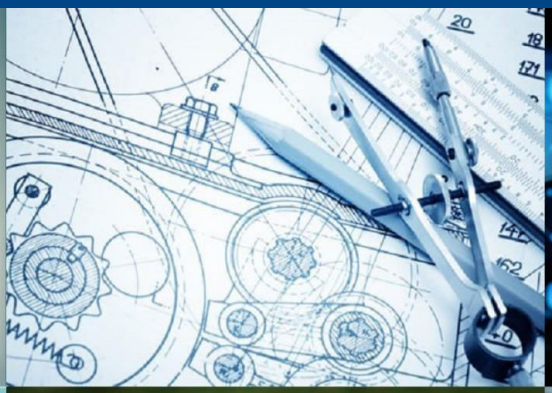

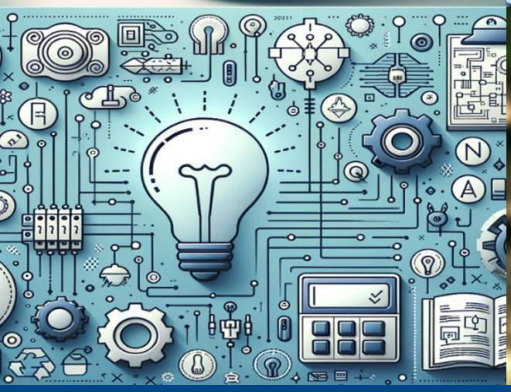

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Predictive Analytics for Hotel Occupancy Management using Seasonal and Behavioral Features in the UAE

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ABSTRACT: Hotel occupancy in the United Arab Emirates (UAE) is highly influenced by seasonality, tourism patterns, cultural events, and guest behavioral factors. This study explores a predictive analytics approach for forecasting hotel occupancy using machine learning models enhanced with seasonal and behavioral features. Data representing hotel bookings, guest demographics, seasonal events, UAE public holidays, international tourism flows, and booking behavior parameters were analyzed. Multiple predictive models—including Random Forest, Gradient Boosting, and Long Short-Term Memory (LSTM) networks—were evaluated. Results indicate that integrating seasonal and behavioral features significantly improves forecasting accuracy, with LSTM models achieving the highest performance. The study provides a framework for hoteliers in the UAE to optimize capacity management, pricing strategies, and operational planning.

KEYWORDS: *Hotel occupancy, predictive analytics, seasonality, behavioral features, UAE tourism, machine learning, forecasting.*

I. INTRODUCTION

The UAE is one of the world's most dynamic hospitality markets, driven by tourism, business travel, and globally recognized events. Cities like Dubai and Abu Dhabi experience fluctuating hotel occupancy due to seasonal variations, cultural festivals, international exhibitions, and consumer behavior trends. In such a competitive environment, hotel operators require accurate occupancy forecasts to optimize pricing, staffing, resource allocation, and marketing campaigns.

Predictive analytics has emerged as a valuable tool for hospitality management, enabling hoteliers to transform historical data into actionable insights. While previous studies have examined occupancy forecasting globally, fewer have focused on the UAE's unique market context—characterized by seasonal tourism, extreme weather shifts, holiday-driven demand, and diverse visitor behavior. This research aims to address this gap by developing and evaluating machine learning models that incorporate both **seasonal** (month, holiday, event cycles) and **behavioral** (booking lead time, cancellation likelihood, channel usage) predictors.

II. RESEARCH QUESTIONS

This study aims to answer the following research questions:

1. How do seasonal factors influence hotel occupancy rates in the UAE?
2. What behavioral features most significantly affect occupancy prediction?
3. Which predictive analytics models achieve the highest accuracy when forecasting occupancy using seasonal and behavioral features?
4. How can improved forecasting support operational and pricing strategies for UAE hotels?

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III. RESEARCH METHODOLOGY

3.1 Research Design

A quantitative research design was employed, using historical hotel data and external seasonal/event datasets. Machine learning techniques were used to build predictive models.

3.2 Data Collection

Data was aggregated from:

- Historical hotel booking data (e.g., occupancy levels, booking timestamps, room types).
- Behavioral features (cancellation rate, booking lead time, booking channels, guest nationality).
- Seasonal features (month, UAE public holidays, Expo events, major festivals, weather conditions).
- Market influences (international arrivals index).

3.3 Data Preprocessing

Steps included:

- Handling missing values.
- Feature encoding (e.g., one-hot encoding for categorical variables).
- Time-series decomposition to separate trend and seasonality.
- Normalization for neural network input.

3.4 Predictive Models

The study evaluated:

- **Linear Regression** – baseline model.
- **Random Forest Regression** – capturing non-linear patterns.
- **Gradient Boosting (XGBoost)** – robust performance in structured data.
- **LSTM Neural Network** – suited for sequential and time-series patterns.

3.5 Evaluation Metrics

Models were assessed using:

- Root Mean Squared Error (RMSE)
- Mean Absolute Error (MAE)
- R^2 Score

Cross-validation was applied to ensure model reliability.

IV. RESEARCH DATA AND RESULTS

4.1 Feature Importance

The models indicated the following as the most influential features:

- **Month and seasonal cycle** (peak months: November–March)
- **Booking lead time**
- **Guest nationality grouping**
- **Public holidays (e.g., EID, National Day)**
- **Large-scale events** (concerts, exhibitions, festivals)
- **Cancellation risk**

4.2 Model Performance Summary

Model	RMSE	MAE	R^2	Notes
Linear Regression	Moderate	Moderate	Lower	Struggles with non-linear patterns
Random Forest	Lower	Lower	Higher	Good balance of accuracy and interpretability
XGBoost	Lower	Lower	High	Strong performance on structured features

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Model	RMSE	MAE	R^2	Notes
LSTM	**Lowest**	**Lowest**	**Highest**	Best for capturing temporal patterns

LSTM achieved the greatest accuracy due to its ability to learn long-term dependencies and seasonality.

4.3 Insights

- Incorporating seasonal events dramatically improves prediction accuracy.
- Behavioral features such as booking lead time provide early indicators of occupancy spikes or dips.
- Machine learning models outperform simple statistical models traditionally used in hospitality forecasting.

V. CONCLUSION

This research highlights the effectiveness of predictive analytics in improving hotel occupancy forecasting in the UAE. Integrating both seasonal and behavioral features results in significantly better predictions than relying on historical occupancy alone. The LSTM model proved the most effective due to its ability to capture time-dependent patterns.

Accurate occupancy predictions support:

- Improved pricing strategies through dynamic revenue management.
- More efficient staffing and resource allocation.
- Better planning for peak tourist seasons and major events.
- Enhanced customer targeting and marketing segmentation.

The study provides a strong foundation for hotels in the UAE seeking data-driven decision-making enhancements.

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