



Big Data Analytics in Predicting Real Estate Marketing Trends

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Abstract: The real estate industry is witnessing a significant evolution through the application of Big Data Analytics, which allows for more precise, data-driven forecasting of market trends. This study investigates how large-scale and diverse data sources—such as property transaction records, demographic statistics, economic indicators, geospatial data, and social media sentiment—can be effectively utilized to predict market behavior. By incorporating machine learning algorithms, statistical modeling techniques, and real-time data analysis, the research demonstrates how predictive analytics can provide meaningful insights for stakeholders like investors, developers, and urban policymakers. The paper outlines a complete data pipeline including data collection, preprocessing, model training, and evaluation using methods like regression, decision trees, and neural networks. Key applications explored include forecasting price trends, analyzing demand and supply, and estimating neighborhood values. Challenges such as data integration, privacy concerns, and the interpretability of complex models are also addressed. The findings emphasize the potential of Big Data to enhance investment decision-making, reduce market uncertainties, and support more informed urban planning strategies.

Keywords: Big Data Analytics, Real Estate Prediction, Housing Market Trends, Predictive Analytics, Property Valuation, Market Forecasting, Real Estate Investment, Data-Driven Decision Making, Real Estate Data Mining.

I.INTRODUCTION

The real estate sector is a cornerstone of global economic activity, influencing financial markets, urban development, and individual wealth. Traditionally, real estate market analysis has relied on historical sales data, economic indicators, and expert judgment to forecast trends. Traditional methods frequently struggle to cope with the scale, speed, and intricacy of today's evolving market landscape. The rise of Big Data Analytics offers innovative possibilities to reshape the way real estate market trends are analyzed and forecasted.

Big Data refers to vast volumes of structured and unstructured data generated at high speed from a variety of sources, including online property listings, transaction records, satellite imagery, social media, demographic data, and IoT devices. The integration of these diverse datasets, coupled with advanced analytics techniques such as machine learning, artificial intelligence, and geospatial analysis, allows for more accurate, granular, and real-time insights into market behavior.

In the realm of real estate, the application of Big Data Analytics empowers key participants—including investors, developers, government officials, and city planners—to uncover trends, foresee market developments, evaluate property worth, and support strategic decision-making. Utilizing predictive algorithms built on complex and diverse datasets, stakeholders can estimate future housing values, spot new investment possibilities, and analyze how external influences such as economic regulations or environmental changes affect real estate market behavior.

This study seeks to investigate how Big Data Analytics can be utilized to forecast trends within the real estate sector, focusing on the techniques, data inputs, analytical tools, and potential obstacles encountered. It also emphasizes the advantages of data-informed predictions in minimizing uncertainty, promoting openness in transactions, and encouraging long-term, sustainable urban development.

The real estate industry is inherently complex, shaped by numerous factors such as economic trends, population growth, interest rates, and consumer behavior. Traditional forecasting methods often struggle to keep pace with the rapidly changing dynamics of the market. The emergence of Big Data Analytics offers a powerful alternative by enabling the extraction of actionable insights from massive, diverse, and high-velocity data sources. These include historical property transactions, demographic patterns, satellite imagery, social media sentiment, and economic indicators. Through the use of sophisticated analytical techniques—including machine learning, data mining, and spatial analysis—Big Data enables more precise forecasting of property values, market behavior, and potential investment prospects. This paper examines the transformative role of Big Data Analytics in redefining predictive practices within the real estate industry, ultimately improving decision-making for developers, investors, and urban planning professionals.



Figure 1: Visual Representation of Big Data Analytics in Real Estate Market Forecasting

II.SOURCES OF BIG DATA IN REAL ESTATE

The real estate industry generates and utilizes a vast amount of data from diverse and rapidly evolving sources. The integration of Big Data allows for more accurate, timely, and granular insights into market behavior and property value fluctuations. The key sources of Big Data in real estate can be broadly categorized as follows:

1.Structured Data Sources

These are traditional, organized datasets typically stored in databases or spreadsheets and are crucial for quantitative analysis.

- **Property Listings and Transaction Records:** This data includes detailed information on sales history, rental prices, property features, square footage, ownership changes, and mortgage records. These structured records provide insights into property values, transaction trends, and investor activity, forming the foundation of real estate market analysis. Additionally, platforms like MLS (Multiple Listing Service) aggregate data on listings and transactions, creating a wealth of information on market trends.
- **Census and Demographic Data:** Provides insights into population growth, income levels, household size, and migration patterns, which are essential for understanding housing demand. Demographic shifts, such as aging populations or urbanization, influence the type and location of real estate investments. Government agencies and organizations like the U.S. Census Bureau collect and maintain these valuable data sets.
- **Economic Indicators:** Interest rates, employment rates, inflation data, and GDP growth influence buying behavior and investment trends. These indicators are critical for predicting future market conditions and informing both short-term and long-term investment decisions. Economic data helps investors understand macroeconomic trends and assess the health of the real estate market.

2.Unstructured and Semi-Structured Data Sources

These sources are less organized but rich in contextual information that can reveal market sentiment and emerging patterns.

- **Social Media and Online Reviews:** Platforms like Twitter, Facebook, and real estate forums reflect public sentiment and opinions on neighborhoods, development projects, or market conditions. Analyzing sentiment through social media content provides a real-time pulse on market trends, neighborhood popularity, and buyer sentiment. Real estate agents and developers use this data to gauge public opinion on properties or areas that are being considered for investment.
- **News Articles and Blogs:** Useful for tracking policy changes, infrastructure developments, and economic trends that may affect property values. By extracting and analyzing text from news articles and blogs, stakeholders can identify new opportunities or potential risks, such as changes in government regulations, new development projects, or shifts in consumer behavior. This data source also serves as an early indicator of trends, helping investors stay ahead of market shifts.
- **Real Estate Portals:** Sites like Zillow, Realtor.com, or MagicBricks host vast amounts of user-generated data, images, and descriptions that can be mined for features like price trends, demand, and availability. These platforms also provide valuable insights into buyer preferences, property features in demand, and price fluctuations. Through web scraping or API integration, analysts can aggregate and process this data to generate market reports, price predictions, and demand forecasts.

3.Geospatial and Environmental Data

Location-based information is vital in assessing a property's worth and appeal.

- **Geographic Information Systems (GIS):** Offer detailed spatial representations, including zoning regulations, land usage

patterns, access to public transportation, and local crime rates. GIS data allows analysts to assess how geographic factors—such as proximity to schools, parks, and amenities—impact property values. It also helps visualize market trends and identify emerging areas of opportunity or risk based on geographic factors.

- **Satellite and Aerial Imaging:** Supports the observation of urban development, green areas, infrastructure growth, and evolving neighborhood dynamics over time. Through the use of satellite images and aerial photography, real estate analysts can monitor construction projects, track land use changes, and even assess the condition of properties. These images can also reveal patterns of urban sprawl, enabling developers to predict future hotspots for development.
- **Environmental Indicators:** Encompass data on air pollution, noise pollution, and flood-prone zones—factors that are becoming increasingly influential in shaping property value and market interest. As environmental concerns grow, data related to sustainability, energy efficiency, and climate risk play an important role in investment decisions. Properties located in areas with high air pollution or flood risks may experience lower demand or reduced long-term value.

4.Sensor and IoT Data

The growing adoption of smart infrastructure has made Internet of Things (IoT) devices a valuable source of continuous, real-time information.

- **Smart Building Systems:** Generate insights on energy usage, occupancy levels, HVAC operations, and routine maintenance requirements. IoT devices installed in buildings collect data on energy efficiency, temperature control, and occupancy patterns. This data helps property managers optimize building performance, reduce costs, and improve tenant satisfaction. Real-time analytics can also enhance predictive maintenance, identifying potential issues before they become costly problems.
- **Mobility and Traffic Insights:** Gathered through GPS, transportation apps, and public transit networks, this data helps evaluate connectivity, commute efficiency, and accessibility. Mobility data plays a significant role in determining a property's desirability. Proximity to transportation hubs or major highways can increase a property's appeal, while areas with high traffic congestion may experience reduced demand.
- **Parking and Infrastructure Sensors:** Real-time data on parking availability, road conditions, and infrastructure usage can provide insights into the accessibility and convenience of a property. This data helps investors assess the impact of infrastructure on property demand, especially in urban areas where parking and traffic are major concerns.

5.Legal and Regulatory Data

Policy-related data can influence real estate pricing and investment.

- **Zoning Laws and Land Use Regulations:** Affect what can be developed and where, directly impacting property valuation. Zoning laws define the types of properties that can be built in specific locations (e.g., residential, commercial, or industrial), influencing property values and investment opportunities. Understanding these regulations helps developers avoid legal complications and ensures that properties meet local codes.
- **Tax Records and Compliance Data:** Provide insights into ownership patterns, liabilities, and government influence on market dynamics. Tax records reveal the financial history of properties, including ownership changes and tax assessments. These records can also indicate potential financial risks, such as properties with outstanding tax liabilities or high property tax rates.
- **Building Codes and Permitting Data:** Help ensure that properties meet safety and structural standards. This data can reveal trends in construction quality, regulatory compliance, and the approval process for new developments.

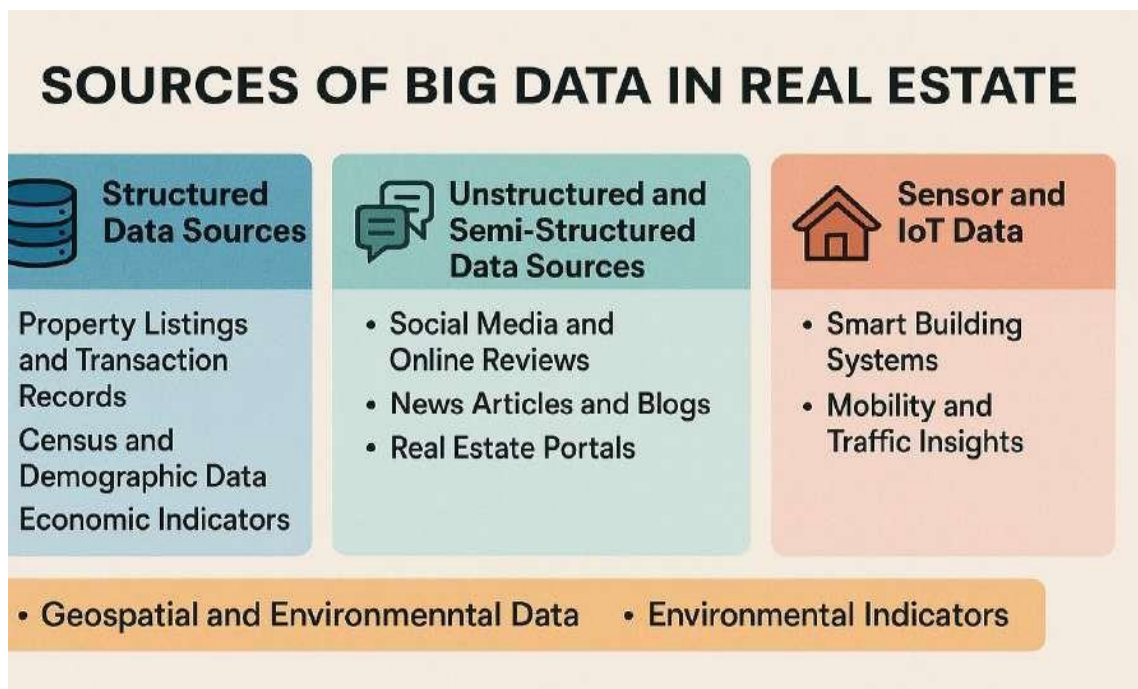


Figure 2: Source of Big data in real estate

III. ANALYTICAL TECHNIQUES AND TOOLS

The effective use of Big Data in forecasting real estate trends relies heavily on the strategic application of advanced analytics and computational methods. These tools help identify subtle relationships, trends, and insights within extensive and multifaceted datasets. This section presents the primary analytical techniques and technologies utilized in real estate data analysis.

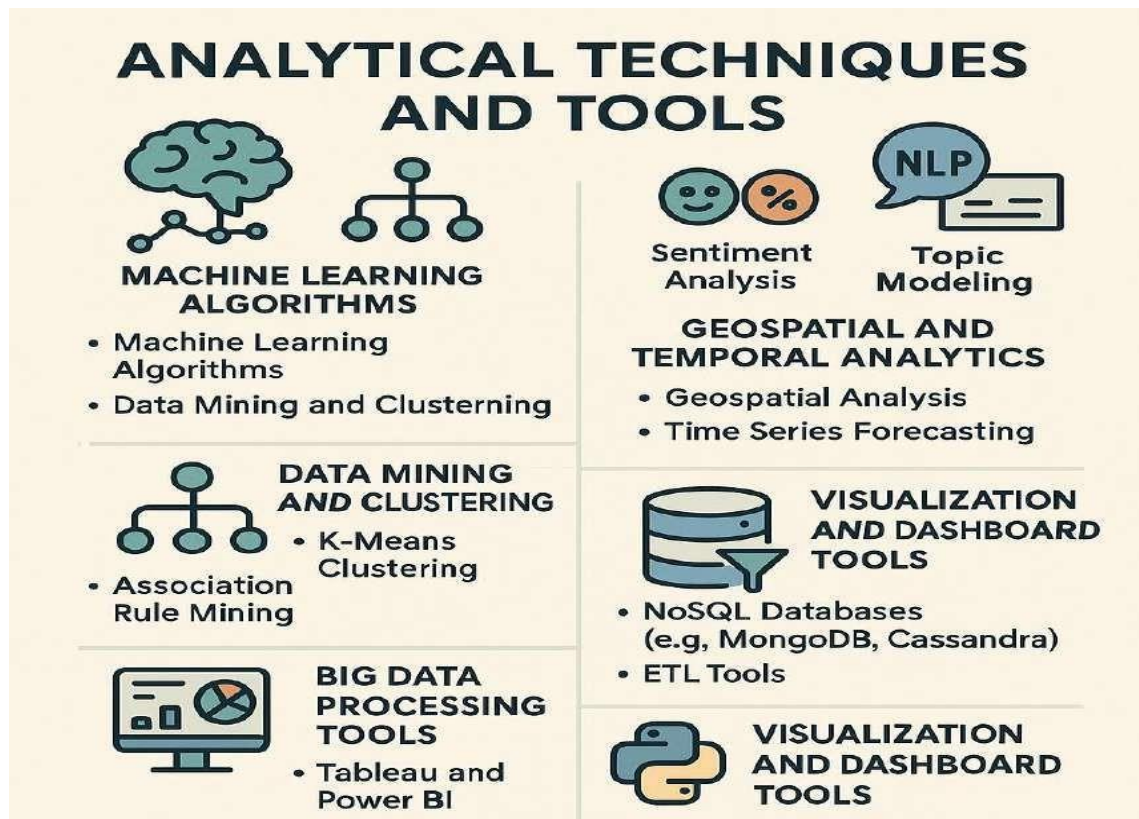


Figure 3: Infographic of Analytical Techniques and Tools in Real Estate Big Data Analytics

1. Machine Learning Algorithms

Machine learning empowers systems to learn from past data and enhance predictive accuracy over time, without the need for explicit programming.

- **Regression Models:** Used for predicting continuous variables such as housing prices based on features like location, size, and amenities.
- **Decision Trees and Random Forests:** These models help in understanding the decision paths in pricing, investment risk, or property classification.
- **Support Vector Machines (SVM):** Used for classification tasks such as segmenting neighborhoods by market category or assessing risk levels.
- **Neural Networks and Deep Learning:** Particularly well-suited for capturing intricate nonlinear patterns within massive datasets, especially when integrating diverse data types like geospatial information, images, or textual content.

2. Data Mining and Clustering

Data mining techniques are essential for uncovering hidden insights within extensive datasets, while clustering helps organize similar data points into meaningful groups.

- **K-Means Clustering:** Commonly applied to classify markets or properties based on attributes such as pricing, location, or buyer interest.
- **Association Rule Mining:** Reveals interdependencies between variables, for example, how proximity to educational institutions influences property values.

3. Natural Language Processing (NLP)

NLP plays a vital role in interpreting unstructured text data sourced from online platforms, social media, and property listings.

- **Sentiment Analysis:** Measures public perception and attitudes toward specific neighborhoods, developers, or broader market dynamics.
- **Topic Modeling:** Detects recurring themes within user discussions and reviews to gain insights into buyer preferences and market concerns.

4. Geospatial and Temporal Analytics

Real estate data is heavily influenced by geography and time, making spatiotemporal analysis essential.

- **Geospatial Analysis:** Tools like QGIS or ArcGIS analyze location-based patterns, such as accessibility or proximity to amenities.
- **Time Series Forecasting:** Models like ARIMA or LSTM networks are used to predict future property prices or market activity based on historical trends.

5. Big Data Processing Tools

Handling large volumes of data requires scalable processing platforms.

- **NoSQL Databases (e.g., MongoDB, Cassandra):** Ideal for storing unstructured or semi-structured data from diverse sources.
- **ETL Tools (Extract, Transform, Load):** Tools like Talend or Apache NiFi are used for cleaning and preparing data for analysis.

6. Visualization and Dashboard Tools

Visualization tools play a key role in translating complex datasets into clear, actionable insights through interactive and user-friendly interfaces.

- **Tableau and Power BI:** Popular platforms for building dynamic dashboards and performing visual data analysis to support strategic decision-making.
- **Python:** Offers powerful libraries for custom data visualization and in-depth statistical analysis, allowing for greater flexibility and control in presenting analytical results.

IV. PREDICTIVE MODELING IN REAL ESTATE

Predictive modeling is a core application of Big Data Analytics in the real estate sector. It involves using historical and real-time data to make informed predictions about future market behavior, enabling stakeholders to reduce uncertainty, identify opportunities, and make strategic decisions. In the context of real estate, predictive models help estimate property values, forecast market trends, assess risks, and evaluate development potential.

1. Property Price Forecasting

A prominent use of predictive analytics is forecasting future property prices. By examining factors like location, property size, condition, neighborhood attributes, and economic trends, predictive models can estimate price movements both in the short and long term.

- **Linear and Multiple Regression:** These methods are frequently employed to understand how property prices are influenced by independent variables, such as square footage, the number of bedrooms, and access to local amenities. Regression models help isolate the relationship between these variables and the target price, providing an intuitive approach to prediction.
- **Machine Learning Models:** Algorithms like Gradient Boosting, Random Forest, and XGBoost enhance prediction accuracy by capturing complex, nonlinear relationships and interactions between variables. These models can learn from large datasets, automatically improving their predictive capabilities as more data becomes available, making them particularly valuable for the dynamic and ever-evolving real estate market.
- **Deep Learning Approaches:** Advanced techniques like neural networks and deep learning are increasingly being explored to further refine property price predictions. These methods can analyze large datasets containing not only traditional property information but also unstructured data like images and descriptions, providing an additional layer of insights for more accurate forecasting.

2. Demand and Supply Forecasting

Forecasting trends in housing demand and supply is crucial for urban development, investment strategies, and construction planning.

- **Time Series Analysis:** Techniques like ARIMA, Prophet, and LSTM (Long Short-Term Memory networks) analyze historical sales and rental data to predict future market demand. Time series models are well-suited for identifying seasonality, trends, and cycles in real estate markets, which are key factors in predicting demand for specific locations or types of properties.
- **Simulation Models:** These models simulate the effects of different scenarios, such as changes in interest rates, population growth, or governmental policies, on housing availability. By testing various "what-if" scenarios, simulation models help stakeholders prepare for potential market shifts, enabling more flexible and adaptive strategies.

3. Neighborhood Trend Analysis

Predictive analytics is applied to assess the future potential of neighborhoods, assisting investors in identifying emerging areas of growth.

- **Clustering and Classification Models:** These models segment neighborhoods into various market categories based on factors such as past growth trends, demographic changes, and infrastructure advancements. By identifying patterns and grouping similar neighborhoods, predictive models help investors target promising areas for investment before they experience significant market shifts.

- **Sentiment-Based Models:** These models incorporate public sentiment from social media and online reviews to gauge the attractiveness of neighborhoods. By analyzing data from platforms like Twitter, Facebook, and real estate review websites, sentiment models provide valuable insights into how the public perceives a given area, influencing property demand.
- **Geodemographic Profiling:** Combining demographic data with geographic location, geodemographic models classify neighborhoods based on factors such as household income, education levels, and cultural preferences. These models help predict which areas are likely to attract specific buyer groups in the future.

4. Investment Risk Assessment

Predictive modeling helps assess investment risks associated with specific properties or portfolios.

- **Logistic Regression and Decision Trees:** Used to predict the probability of default, vacancy, or price drop, these models analyze patterns in property data to identify early warning signs of investment risk. Logistic regression can help predict binary outcomes (e.g., whether a property will experience a price drop), while decision trees provide a visual representation of potential decision paths and their corresponding probabilities.
- **Portfolio Optimization Models:** Apply predictive analytics to balance risk and return in real estate investment portfolios. These models consider factors like property type, location, historical performance, and market trends to help investors diversify their portfolios and mitigate exposure to potential losses.
- **Credit Scoring Models:** In the context of real estate financing, predictive models can assess the creditworthiness of potential borrowers. By evaluating factors such as payment history, income stability, and debt-to-income ratios, these models help lenders make more accurate lending decisions and predict the likelihood of mortgage defaults.

5. Integration with External Data

Modern predictive models often combine real estate data with broader datasets, including economic forecasts, climate data, and mobility patterns.

- **Geospatial Predictive Models:** These models incorporate GIS data to predict value changes influenced by location-specific factors, including zoning modifications and environmental risks. Geospatial analytics allows for more granular predictions by considering the spatial relationships between properties and their surrounding environments, such as proximity to schools, parks, or transportation hubs.
- **Hybrid Models:** By blending economic, behavioral, and spatial data, hybrid models offer a more robust and comprehensive framework for forecasting real estate trends. Combining multiple types of data sources enhances the predictive power of these models, enabling more accurate and reliable forecasts across various market segments.
- **IoT and Smart Building Integration:** As smart homes and IoT devices become more common in real estate, predictive models can incorporate data from these sources, such as energy consumption, security metrics, and occupancy patterns. This integration provides deeper insights into the functionality and desirability of properties, influencing market value and rental yields.

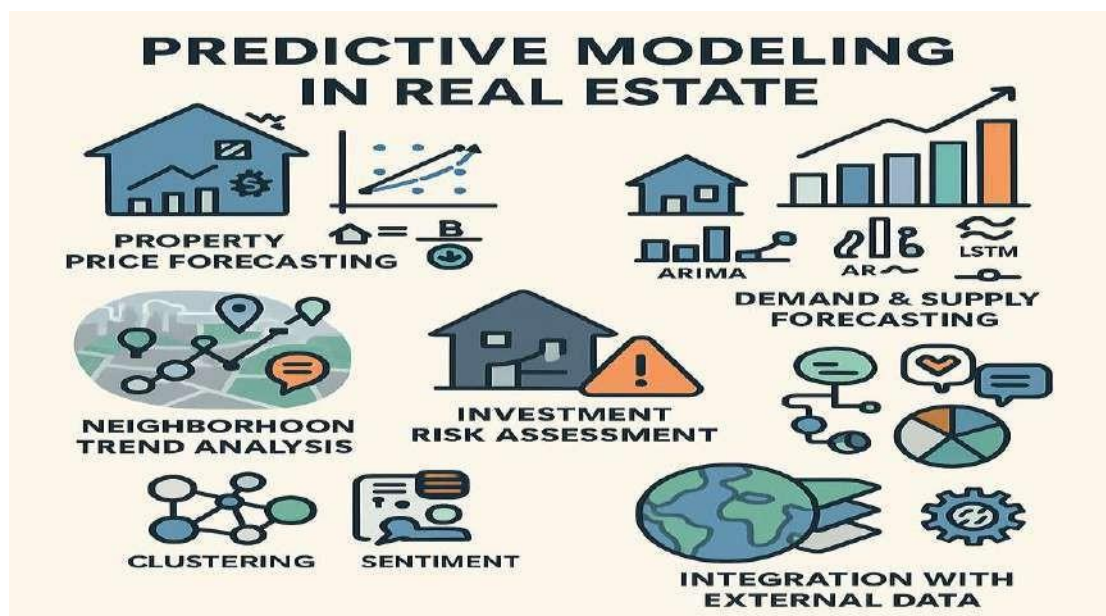


Figure 4: Predictive Modeling in Real Estate – Applications and Techniques

V.FUTURE PROSPECTS

As technological advancements continue to accelerate, the future of Big Data Analytics in real estate prediction holds immense promise. Emerging tools, data sources, and analytical methods are expected to further enhance the accuracy, scalability, and real-time capabilities of market forecasting. These developments are set to redefine how real estate stakeholders—investors, developers, policymakers, and urban planners—make informed decisions.

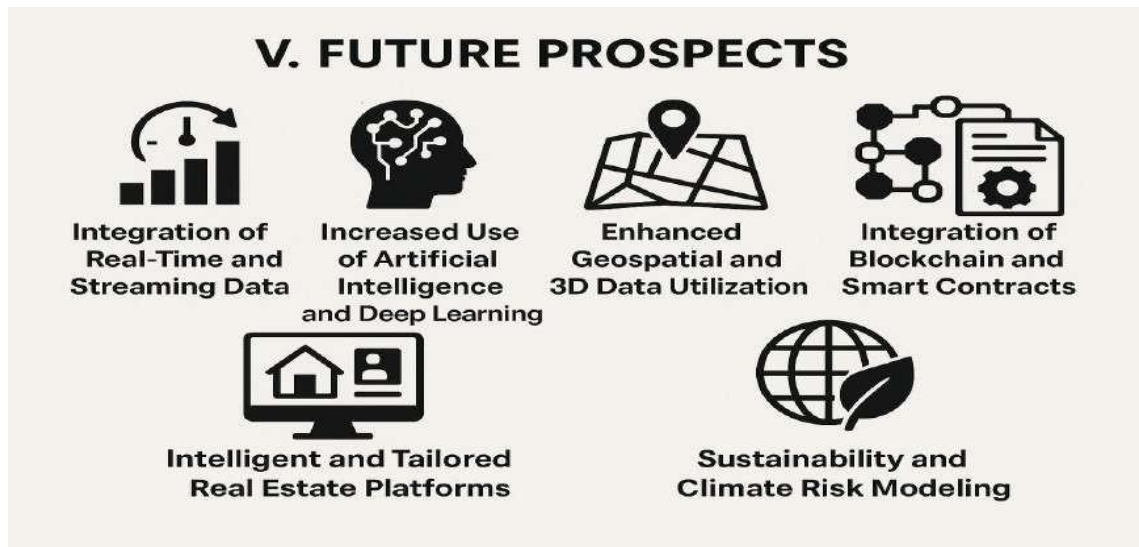


Figure 5: The future prospects of Big Data Analytics in real estate

1.Integration of Real-Time and Streaming Data

The future of real estate analytics will involve more real-time data ingestion from sources like IoT sensors, smart city infrastructure, and live transaction feeds. This will enable up-to-the-minute market monitoring, dynamic pricing models, and immediate risk assessment, enhancing responsiveness to sudden economic or environmental shifts.

2.Increased Use of Artificial Intelligence and Deep Learning

Advanced AI and deep learning models, particularly Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), will be increasingly applied to analyze images, text, and time-series data. These models can offer more nuanced predictions, such as identifying property features from photos or detecting early signs of gentrification through social media trends.

3.Enhanced Geospatial and 3D Data Utilization

Future analytics will incorporate high-resolution satellite imagery, drone footage, and 3D mapping to assess neighborhood development, land use, and structural conditions. This can significantly improve site evaluation, risk assessment, and infrastructure planning.

4.Integration of Blockchain and Smart Contracts

The use of blockchain in real estate is poised to significantly improve transparency, data integrity, and transactional security. Smart contracts will facilitate the automatic execution of agreements, reducing the need for intermediaries and minimizing errors or delays. Additionally, decentralized property ledgers can help prevent fraud and enhance the reliability of data used in predictive analytics.

5.Intelligent and Tailored Real Estate Platforms

Leveraging Big Data, real estate platforms will evolve to offer highly personalized experiences by analyzing individual user behaviors, preferences, and financial situations. Predictive tools will go beyond matching users with properties—they will also identify ideal purchasing windows and strategic investment opportunities, making property recommendations more timely and data-driven.

6.Sustainability and Climate Risk Modeling

Future models will integrate environmental and climate data to predict long-term risks such as flooding, heat exposure, and air pollution. These insights will be critical for sustainable urban development and for assessing the long-term value and livability of properties.

7.Expansion across Developing Economies

With the ongoing enhancement of digital infrastructure in emerging markets, the adoption of Big Data Analytics is set to grow significantly in regions that have historically lacked robust predictive tools.

This increased accessibility holds the potential to drive more inclusive economic development and foster housing policies that are grounded in real-time data and localized insights, contributing to better planning and equitable growth on a global scale.

8.Cross-Sector Data Collaboration

The future of predictive real estate analytics will involve increased data-sharing between sectors such as transportation, healthcare, education, and finance. This integration will provide a more holistic view of livability and growth potential, empowering urban planners and policymakers with richer contextual insights.

9. Ethical and Responsible AI Use

As AI becomes more pervasive in real estate decisions, ethical considerations will gain prominence. Future tools will be developed with built-in fairness, transparency, and privacy safeguards to ensure responsible data usage and avoid reinforcing social or economic bias in predictive models.

10. Virtual and Augmented Reality Integration

Enhanced visualization through VR and AR will allow stakeholders to explore predictive models in immersive environments. Buyers can simulate future neighborhood changes, while developers and investors can evaluate design options and risk scenarios in real time.

VI. CONCLUSION

The integration of Big Data Analytics into the real estate industry represents a paradigm shift in how market behavior is monitored, interpreted, and anticipated. By leveraging extensive datasets—ranging from transaction records and demographic trends to sentiment analysis and geospatial intelligence—industry stakeholders can now make more informed, data-driven decisions with improved precision.

This paper has highlighted the major sources of Big Data in real estate, explored the analytical tools and methodologies used to extract actionable insights, and examined how predictive modeling is employed to forecast property values, housing demand, and neighborhood evolution. The adoption of sophisticated machine learning models, geospatial technologies, and real-time analytics has provided a significant edge over conventional forecasting approaches.

While the advantages are compelling, challenges remain. Issues such as data accuracy, user privacy, and the need for cross-disciplinary collaboration continue to shape the path forward. However, advancements in AI, IoT, block chain, and environmental modeling are poised to address many of these limitations, unlocking new levels of reliability and scale in predictive analytics.

In addition to improving investment strategies and urban planning, Big Data Analytics is also contributing to greater transparency in the real estate sector. By making data-driven insights more accessible to all stakeholders—including homebuyers, local governments, and developers—it fosters accountability and reduces information asymmetry. This democratization of data ultimately supports more equitable and efficient real estate markets.

Moreover, as sustainability becomes a growing concern, the use of Big Data can help identify patterns related to energy usage, environmental impact, and long-term viability of real estate projects.

Integrating environmental data with economic and demographic indicators allows decision-makers to prioritize green development, assess climate risks, and design smart infrastructure that aligns with the principles of sustainable urban growth.

As Big Data technologies evolve, they will increasingly support personalized real estate services, providing tailored experiences for both buyers and sellers. Customization options that address specific needs—such as location preferences, budget constraints, and desired amenities—are already being explored by real estate platforms using machine learning algorithms. This results in a more targeted approach to matching buyers with properties, improving satisfaction and reducing the time spent in the market.

Looking ahead, it is crucial that the real estate industry continues to innovate and adapt to these technological advancements. Ongoing research into emerging fields, such as Quantum Computing, will likely further enhance Big Data Analytics, unlocking even more powerful tools for analyzing and predicting market behavior. As these technologies mature, they will help create smarter, more sustainable, and highly adaptable real estate ecosystems.

In conclusion, Big Data Analytics holds the potential to reshape the real estate landscape significantly. By continuing to harness the power of data, the industry can expect to see improved decision-making processes, more equitable market opportunities, and a higher standard of sustainability and efficiency in both urban and rural developments.



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