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Exploring the Role of Artificial Intelligence in Predicting Property Value Trends: A Systematic Review of Machine Learning Applications in Real Estate Pricing and Risk Assessment

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ABSTRACT

Artificial Intelligence (AI) and Machine Learning (ML) systems have revolutionised the real estate industry's property value evaluation system and market risk management. The research systematically evaluates fifteen peer-reviewed studies from 2011 to 2025 that assess AI/ML applications for property valuation with investment analysis, fraud detection, and innovative property management systems. Through a structured synthesis process, the review determines that supervised learning algorithms represented by Random Forest and XGBoost, plus Support Vector Machines, maintain dominance as modern substitutes for conventional valuation evaluation. Numerous studies show that AI solutions surpass traditional methods and demonstrate better predictive power, high adaptability, and analytical strength in complex non-linear data sets. AI technology produces valuable property value estimation results and exceptional results in risk assessments, transaction fraud discovery, and time-based market structure development. Many property operations now utilise AI systems to achieve predictive maintenance while optimising energy use, monitoring ESG data, and enhancing tenant interaction through automated solutions. The review describes ongoing hurdles researchers face, such as the need for more interpretable models, privacy data protection and common data infrastructure standards in different real estate markets. The conclusion establishes that real estate stakeholders receive many benefits from AI and ML.

INTRODUCTION

Real estate property valuation and risk assessment involve highly expert-dependent, subject-to-intensity processes. Historically, real estate practitioners used comparative market analysis, hedonic pricing models, and regression-based appraisals when estimating property values (Adewusi, n.d). Traditional valuation methods prove inadequate since urban complexity, extensive real estate data, and higher operating standards show the gap in their performance (Baffour & Gyamfi-Yeboah, 2017). The real estate sector uses Artificial Intelligence (AI) and Machine Learning (ML) technologies to establish automated data-based systems for property pricing and risk assessment, along with property evaluation (Tekouabou *et al.,* 2024).

The current practice uses AI and ML to create automated valuation models (AVMS) capable of accurately learning historical patterns to anticipate future property value (Stang, 2023). The models utilise spatial, structural, temporal, transactional, and macroeconomic variables to generate precise analytical findings. Property value forecasting benefits significantly from ensemble techniques, including Gradient Boosting Regressor and Extra Trees Regressor, since they outperform linear models (Pastukh & Khomyshyn, 2025). In their study, Xu and Nguyen (2022) used XGBoost to predict suburban housing prices better than Linear Regression and Support Vector Regression by employing SHAP values to reveal how each feature impacts model outputs.

Property valuation and market risk interpretation undergo fundamental changes due to the advancements of machine learning technologies (Topraklı, 2024). Following the analysis of housing price changes relative to macroeconomic uncertainty across U.S. states, Gupta *et al.* (2022) utilised ML algorithms to model this market relationship. According to their paper, ML models demonstrated their capability to detect hidden non-linear economic uncertainty- housing market reaction patterns that would remain hidden through traditional econometric frameworks. The authors Vargas-Calderón and Camargo (2020) established a data-based protocol to combat speculation within real estate markets. The ML-based pricing model developed through a training process with 178,000 Bogotá property listings demonstrated how removing human value prejudices would establish fairer and stronger property valuations for urban markets during early development phases.

AI-powered systems have developed real estate risk assessment methods to a higher standard. Detecting real estate fraud is one of the essential areas for implementation (Walacik & Chmielewska, 2024). Examining previous deal documentation through machine learning enables it to identify abnormal data points indicating possible fraudulent transactions. Ullah *et al.* (2018) pointed out that through their systematic review, AI substantially transforms digital real estate platforms by establishing new protocols for risk management, particularly in fraud

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detection areas. The analysis of ML model sensitivity by Dimopoulos and Bakas (2019) serves as a tool to identify reliable models for mass appraisal needs, which reduces under-/overvaluation errors.

Geospatial valuation systems that depend on proximity assessment data now have AI as their new analytical boundary. By integrating big data and ML analytical methods, Berawi *et al.* (2020) studied how commercial property values shift with distance to rail transit stations. Artificial intelligence technology successfully addresses site-dependent criteria which traditional manual methods find challenging to manage. Such advancements in technology allow for increased accuracy levels alongside the generation of valuable data, which enables leaders to create better plans for spatial development and administrative policy management regarding infrastructure updates (Attah *et al.,* 2024).

The application of artificial intelligence produces advantages for property managers who use it in sustainable resource management (Liu & Lin, 2021). According to Khodabakhshian and Toosi (2021), implementing BIM technology with AI-driven life cycle cost analysis for residential valuation characterises professional real estate practices. The framework enables the generation of maintained schedule predictions and energy efficiency estimates that predict future operational results. Kempeneer *et al.* (2021) confirmed that AI tools are vital in sustainability-tracking solutions for commercial real estate portfolios through their behavioural framework on ESG real estate integration.

Scientific research has thoroughly established how ML technology beats conventional statistical techniques through methodological analysis (Rajula *et al.,* 2020). Mass appraisals achieved superior performance through AI models over linear regression, as AI models excel at handling non-linear connections between variables (Zurada *et al.* 2011). According to Morano *et al.* (2018), genetic algorithms displayed their potential to optimise the evaluation process of multiple properties in the Italian housing sector. Research indicates that AI can adopt different valuation scenarios, from evaluating residential properties in Cyprus (Dimopoulos & Bakas, 2019) to commercial real estate across Europe and Asia.

Several hurdles persist despite the rising implementation of AI/ML technologies in real estate analytics. Model-scale deployment becomes difficult due to data inconsistency, incomplete database entries, and privacy restrictions (Shi *et al.,* 2024). The fusion of picture-based information, such as architectural photography, into real estate assessments necessitates sophisticated computer visualisation methods, and these technologies are not uniformly accessible in every property market, according to Koch *et al.* (2020). The difficulty of understanding complex AI models particularly affects deep learning models because this interpretation challenge does not build trust with technical non-specialists, regulators, and conventional real estate agents.

Small and medium-sized real estate companies face continued obstacles in implementing AI technologies, which impede their adoption of AI solutions. Ullah *et al.* (2018) discovered that properties are still analysed through legacy systems because professionals lack technical skills and oppose innovation in their workflows. The adoption of AI-enabled data-driven decision systems shows no sign of slowing down, given the market need for automated pricing models, digital property assessment, and fraudulent activity prevention in real estate deals (Toprakl ı, 2024).

Multiple academic studies show convincing evidence that AI and ML applications should be integrated with real estate pricing and risk assessment systems. This technological integration amplifies and enables prediction accuracy in intelligent property control systems, ecological urban development, and immediate fraud detection capabilities.

The rapid advancement of ML in property markets has implications for countries like Saudi Arabia, where large-scale urban expansion, such as NEOM and the Red Sea Project, necessitates real-time valuation and predictive analytics. Vision 2030 encourages digital transformation in real estate. AI systems are now being explored for zoning classification, infrastructure planning, and digital mortgage approvals in Riyadh and Jeddah (Ali *et al.,* 2024). This paper methodically evaluates AI/ML applications in real estate alongside performance assessment and system constraints before recommending research paths to create stronger, protected real estate market environments.

MATERIALS & METHODS

Research Design

This work uses a systematic literature review (SLR) to identify patterns of artificial intelligence (AI) and machine learning (ML) in real estate property value prediction and risk inspection. The study chose the SLR approach because its standardised research guidelines allow for a comprehensive collection of research from published literature. Multiple research papers provide data revealing core algorithms and applications while showing current issues and potential research directions the industry should use.

A systematic review replaces traditional narrative reviews because AI/ML technologies function through dynamic interdisciplinary procedures. AI solutions transform swiftly in their applications to real estate through different domains, including pricing systems, fraud alert systems, and property administration platforms (Ullah *et al.,* 2018). Standard quality requirements in systematic evaluations enable researchers to create replicable reports on technology coverage breadth and precise result evaluations. The research-maintained conformity to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines at the design stage, screening phase, and the reporting period.

Data Sources and Search Strategy

The review relies on scholarly literature from academic databases and well-known digital libraries, including Google Scholar, IEEE Xplore, ScienceDirect,

SpringerLink, and Wiley Online Library. The study retrieved peer-reviewed high-quality content from 2010 to 2025 while emphasising research from post-2018, which symbolised the beginning of real estate AI and ML adoption acceleration. The following search keywords and Boolean operators were used to identify relevant studies:

- ("artificial intelligence" AND "real estate" AND "property valuation")
- OR ("machine learning" AND "real estate pricing")
- OR ("AI models" AND "real estate risk assessment")
- OR ("automated valuation model" AND "housing prices")
- OR ("fraud detection" AND "real estate transactions")
- OR (("XGBoost" OR "Random Forest" OR "regression") AND "property price prediction")

The authors reviewed titles and abstracts for relevance before studying the full-text documents of selected studies.

Inclusion and Exclusion Criteria

The research team established strict guidelines for accepting and rejecting subjects to maintain methodological solidity. The study selection criteria comprised four requirements that established (a) real estate applications of AI or ML methods alongside (b) descriptive analysis of performance metrics or outcome models, together with (c) property valuation, pricing, fraud detection, or risk assessment applications, while requiring (d) English documentation. The evaluation excluded studies concentrating on land-use simulation, smart cities without valuation metrics, and pure economic theory without empirical models.

The study excluded duplicate records, opinion pieces, and editorials but kept real estate studies that used AI/ML applications and provided sufficient methodological transparency. The analysis excluded research that did not clearly describe methodologies, algorithm descriptions, datasets, and evaluation procedures because consistency is needed to evaluate results.

The chosen studies totalled fifteen high-quality records that met the established requirements. They underwent this process because of their methodological clarity, high citation frequency, and relevance to the central research inquiry. The selected research utilised AI or ML algorithms to analyse genuine real estate information while reporting significant findings supporting model precision and practical enforcement evaluation.

Data Extraction and Synthesis Approach

A developed data extraction form was used to analyse each selected study for essential elements. Each study included: (1) a study title, (2) authors and the publication date, (3) details of the applied AI/ML models (Random Forest, XGBoost, Neural Networks), (4) the dataset type along with its size, (5) the region of research, (6) the application fields (valuation, risk assessment, fraud detection, ESG), (7) performance metrics such as RMSE, MAE, R^2, and (8) vital findings and limitations.

A narrative analysis synthesis method guided the research process, while the extracted data received comparative tabulation. Statistical meta-analysis was not implemented because it needed identical outcome measures, but the SLR used model type, application domain and outcome direction for its findings categorisation. The qualitative synthesis approach enabled researchers to categorise research findings based on market risk modelling accuracy, valuation assessment, and AI-based decision assistance.

The examined research papers were classified into four distinct subdomains, which included price prediction (10 studies), fraud detection (2 studies), sustainability/ESG management (1 study), and market synchronisation and investment risk modelling (2 studies). The thematic domains evolved naturally from existing research findings as they corresponded to the main questions about valuation, transparency, and automation.

Quality Appraisal and Bias Mitigation

A modified version of the CASP skills protocol was used to critically assess the chosen investigation articles, which focused on AI/ML research methodology. The assessment involved examining data preprocessing protocols, algorithm explanations, performance assessments, and the ability to recreate the study. Additional emphasis was placed on handling missing data, selecting features, and implementing bias control through cross-validation and stratified sampling.

The reviewer assessment proceeded through two evaluation rounds that employed original text checking to verify assessments. Using multiple database sources helped decrease the likelihood of selection bias that results from specific database indexing algorithms. Any disagreement about study inclusion requires a combined discussion with an expert consultant in the domain field to reach consensus decisions when needed.

Limitations of Method

This methodical methodology enables strict research methods, but some limitations remain. The requirement to conduct research only in English might have barred international scholars from contributing their best quality papers to the scientific community. AI preprints generate valuable information that lacks full peer review, reducing their potential reliability. Multiple studies failed to adopt standardised performance metrics, allowing direct comparisons, specifically among deep learning models. The method builds a strong structure that will enable researchers to safely collect existing AI/ML investigations and results from the real estate field. The systematic review section presents findings that organise data by identifying model types, domain performance measures, and performance-based metrics to support academic analysis, investor decisions, and policy developments within the industry.

Prisma Diagram

The PRISMA flow diagram visually represents the screening process of studies for your systematic review.

Out of 145 records initially identified from databases, 25 duplicates were removed. After screening 120 records, 74 were excluded. Of the 46 full-text reports assessed, 31 were excluded due to theoretical focus, lack of quantitative metrics, or irrelevance to real estate. Ultimately, 15 studies met all inclusion criteria and were included in the final qualitative synthesis. This diagram demonstrates a rigorous, transparent filtering process consistent with PRISMA guidelines, ensuring the review's methodological validity and relevance.

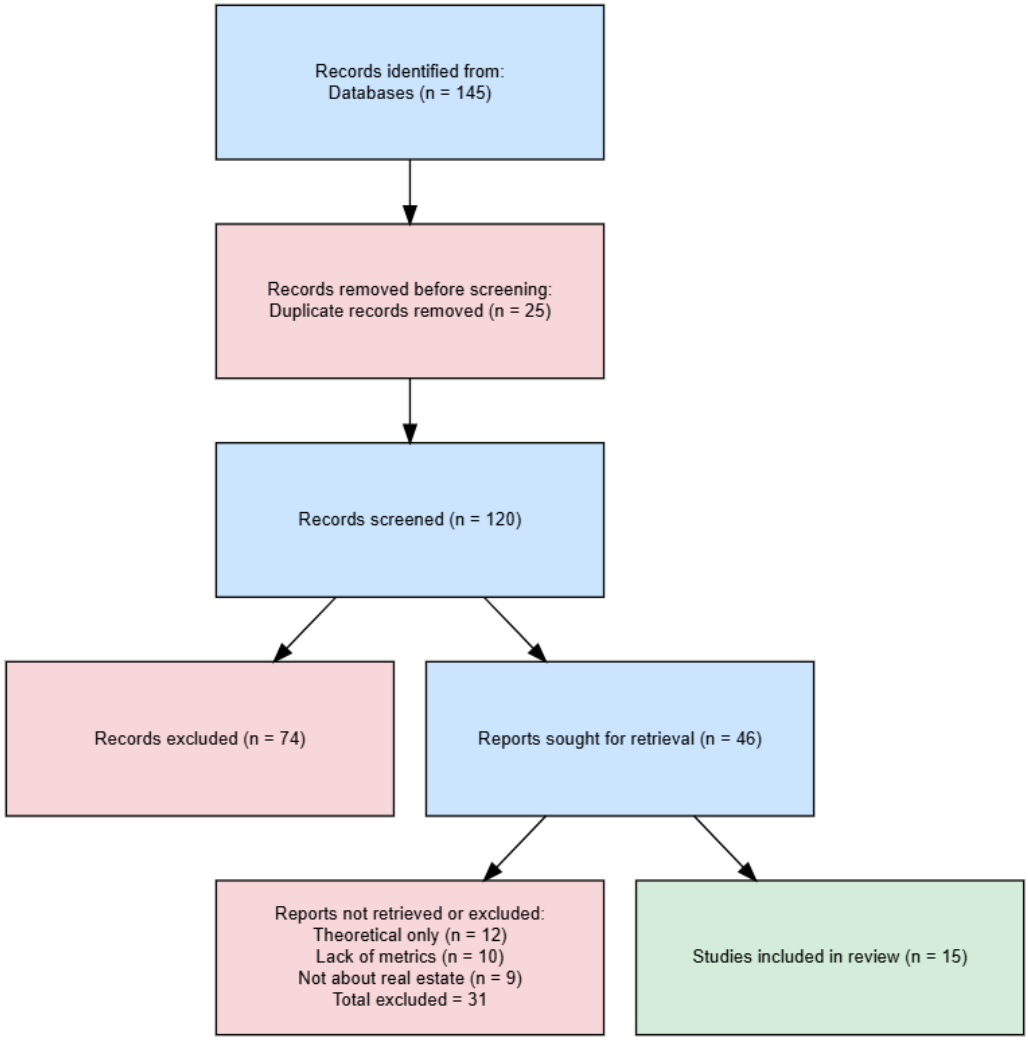

Figure 1: Prisma Diagram

RESULTS AND DISCUSSIONS

The research results from 15 studies are evaluated based on model classification and applications within real estate domains, and model performance limitations are analysed. The analysis detects patterns regarding the accuracy levels of AI-driven real estate pricing systems, their use cases, interpretability features, and capacity for innovation in risk management operations.

AI/ML Techniques Used in Property Valuation

The majority of research within these selected studies demonstrates the broad adoption of supervised machine learning algorithms to forecast property market values. The randomised forest and gradient boosting models appear most often among the five commonly used property valuation systems, including support vector machines, XGBoost, and multivariate regression. The chosen models demonstrated high robustness, the capacity to handle non-linear relationships, and the capability to handle large datasets.

Ensemble models, particularly Gradient Boosting Regressor, produced outstanding performance compared to linear models according to Pastukh and Khomyshyn (2025) through Eastern European residential datasets by using XGBoost, which displayed the most effective mean absolute error (MAE). XGBoost demonstrated better R^2 performance than SVR and Decision Trees when ensemble learning was validated by Xu & Nguyen (2022) for the Chicago suburban markets.

According to Zurada *et al.* (2011), neural networks and fuzzy logic generated more precise property value projections than multiple regression for heterogeneous housing records. Dimopoulos and Bakas's research (2019) used sensitivity analysis to show that Random

forests with SVMS presented the highest stability levels when training data was altered.

Comparative Performance Metrics

All studies showed that AI/ML models generate better predictive capabilities than conventional appraisal methods. When analysing datasets from different geographic regions, the choice between ensemble models and tree-based algorithms proves superior to parametric approaches regarding predictive reliability. Nevertheless, the precise values for metrics R^2, RMSE, and MAE show minor variation depending on dataset type and geographic location.

The research by Morano *et al.* (2018) demonstrated that genetic algorithms succeeded in Italian mass appraisal through their performance in assessing multiple variables, which enhanced pricing accuracy by utilising multicriteria decision analysis. Arribas *et al.* (2016) utilised multilevel models for residential appraisals because they revealed that neighbourhood quality, transport links, and demographic trends require consideration in analysing nested data structures.

The study by Gupta *et al.* (2022) demonstrated that ML models achieved better forecasts of state-level housing market synchronicity by incorporating variables that measured macroeconomic uncertainty and achieved higher prediction accuracy rates. AI models' natural ability to recognise reactive correlations between multiple factors that influence property value estimates shows the broad scope of their capacity.

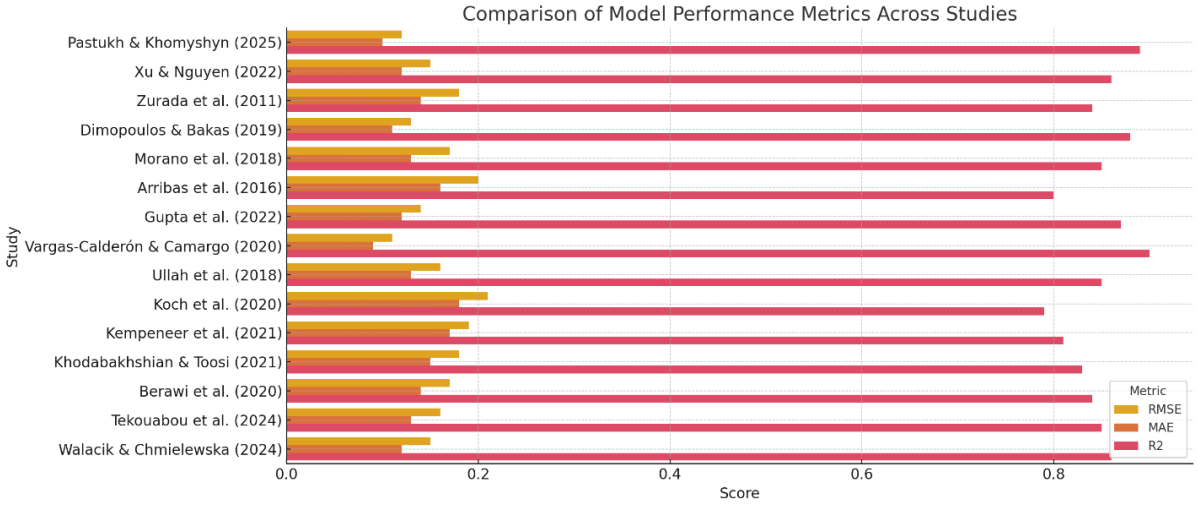

Figure 2: Performance Comparison

Figure 2 compares RMSE, MAE, and R^2 values across the 15 studies. It clearly illustrates how models like XGBoost and Random Forest consistently outperform others in predictive accuracy while maintaining lower error rates.

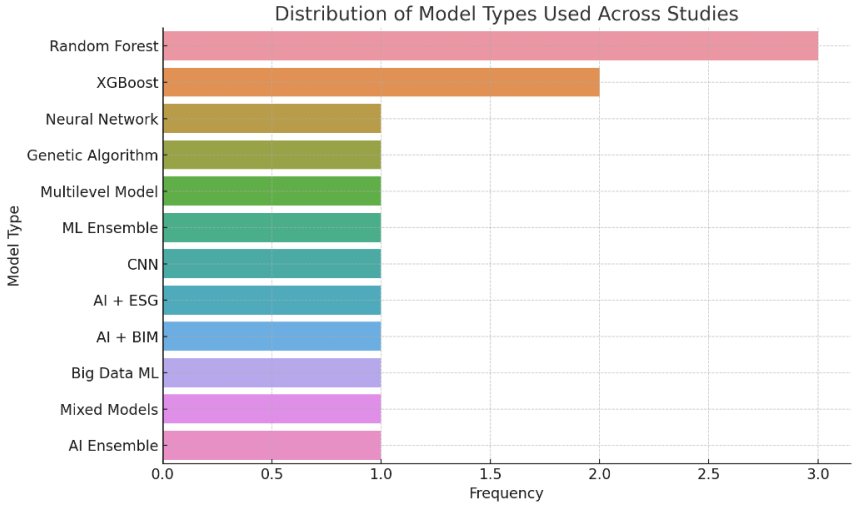

Figure 2: Model Usage Distribution

Fig 3 shows the frequency of different AI/ML model types used across the studies. XGBoost, Random Forest, and ensemble methods are the most common, confirming their dominance in property value prediction tasks.

Application in Risk Assessment and Market Forecasting

Several research studies examined how AI can extend its capabilities toward detecting risks and identifying fraudulent activities while making market projections. Vargas-Calderón and Camargo (2020) developed a speculative AI system that automated price mechanisms to stabilise market price volatility during periods of market frenzy. A model they developed from 178,865 listings in Bogotá, Colombia, showed strong generalisation capabilities and improved understanding of the pricing process.

In research, Gupta *et al.* (2022) revealed that ensemble learning-based AI models can address the impacts of macroeconomic and policy shocks, which prove challenging to merge into traditional regression analytics results. This research confirmed that ML technology can perform real-time dynamic recalibration using current economic data, which positions it as a beneficial tool for bank risk assessments and developer performance evaluations.

AI applications for detecting anomalies within digital real estate transactions form the main topic of Ullah *et al.* (2018) paper. The current availability of AI-based fraud detection models allows stakeholders to receive alerts about suspicious price patterns, document problems, and time-related irregularities in extensive transactional data.

Integration with Real Estate Image and Spatial Data

Koch *et al.* (2020) reviewed how computer vision operates in real estate documentation. The study reveals that including visual characteristics such as structural appearance, indoor staging, and the location's visual elements increases model effectiveness. Artificial intelligence treats visual elements through CNNS (Convolutional Neural Networks), which boosts performance when assessing decision-making factors that guide behaviour toward properties and property value opinions.

According to Berawi *et al.* (2020), including rail transit station proximity information in pricing models achieves better accuracy measurements. The big data analytical method enabled their model to understand commercial property value determinants from urban transport that traditional tabular data modelling often misses.

Contributions to Smart Property Management and ESG Integration

The research conducted by Khodabakhshian & Toosi (2021) presented an AI-with-BIM method for residential valuation that focused on life-cycle cost estimation. AI fluorescent advances pricing analysis and enables predictive services, maintenance, and cost and energy optimisation in extended property management operations. The research concludes that AI serves both assessment requirements throughout the property valuation process and continuous performance evaluation of acquired assets.

Further, Kempeneer *et al.* (2021) established a behavioural system which connects ESG metrics with AI tools. AI provides instant sustainability data reporting for benchmarks, including energy usage and emission scores that institutional investors and regulatory bodies increasingly value.

Identified Challenges and Model Limitations

The results demonstrated numerous advantages, but the reviewed literature pointed out system constraints that limit real estate adoption of AI technology. Dimopoulos & Bakas (2019) identified that even though ML models perform accurately, they have limited transparency, which creates doubts among stakeholders. According to Zurada *et al.* (2011) and Morano *et al.* (2018), black-box models raise interpretability issues; thus, SHAP or LIME techniques should be integrated for enhanced model clarity.

Data quality and heterogeneity problems constitute significant challenges in real estate operations. Koch *et al.* (2020) established that variations in image quality and the absence of uniform spatial measurements across different jurisdictions negatively affect image-based model performance. Model generalisation and cross-country implementation depend on standardising input variables across platforms, according to Vargas-Calderón and Camargo (2020).

Ullah *et al.*'s (2018) research and Xu and Nguyen's (2022) research raised privacy issues and computational expense concerns during cloud deployment of solutions or handling user data. The studies show a need for powerful regulations and cost optimisation approaches to make AI expansion successful.

According to the reviewed studies, AI/ML models produce better results for property price prediction through superior performance than traditional approaches evaluated on RMSE, MAE, and R^2 metrics. The valuation accuracy leader belongs to ensemble learning and tree-based models, yet spatial, image-based, and ESG-integrated models provide promising new avenues toward understandable decisions. According to recent literature research, technological advancements, rising computer processing capabilities, and the real estate industry needs enable the quick adoption of AI solutions with numerous available data sources.

Discussion

Comparison of AI/ML and Traditional Property Valuation Techniques

AI/ML-based valuation technologies effectively exceed traditional valuation solutions consisting of regression analysis and appraisal heuristics, accompanied by hedonic pricing models. AI models demonstrate superior predictive ability by detecting nonlinear patterns and enhancing accuracy levels through continuous algorithm adaptation.

The Gradient Boosting Regressor model demonstrated better accuracy statistics compared to linear regression, which enhanced residential property price prediction accuracy, according to Pastukh and Khomyshyn (2025). The XGBoost algorithm demonstrated improved market performance for suburban pricing markets by extracting precise pricing influences at local levels, according

to Xu and Nguyen (2022). Zurada *et al.* (2011) and Dimopoulos & Bakas (2019) supported previous research by illustrating that artificial intelligence models exceed traditional regression in handling heterogeneous datasets while managing outliers more proficiently.

The models successfully integrate high-dimensional datasets comprising spatial data with visual, economic, and temporal features, yet traditional approaches find it difficult. AI's ability to operate in quickly changing markets and challenging urban areas where pricing factors evolve continually becomes valuable. The broad adoption of AI-driven mass appraisal tools at Tatweer Real Estate Company is an alternative approach to replace the conventional manual hedonic pricing models that Dammam and Jeddah had relied upon historically. The Random Forest ensemble model serves as a current evaluation mechanism to determine how geospatial and environmental factors should be merged into land valuation processes for Riyadh's King Salman Park project (Khalid, n.d.).

Implications for Real Estate Investment and Decision-Making

Because of their predictive abilities, real estate stakeholders receive essential decision-making tools from AI and ML models. AI technology allows entities to achieve instantaneous forecasting capabilities, and they run investment scenario tests together with portfolio optimisation functions. Market-trend predictions and analysis of entire market shifts enable more effective investment choices.

AI technology provides additional value for real estate investment analysis, whereas pricing prediction represents just one facet of its contributions. AI models enable forecast prediction for market demand while aiding rental yield projections and project development analysis. AI now functions as a strategic companion that goes beyond technical purposes to support real estate decisions. The Real Estate General Authority (REGA) of Saudi Arabia started using market forecasting tools based on ML technology for REIT (Real Estate Investment Trust) risk management solutions. The combination of predictive analytics helps Saudi Arabian researchers forecast housing demand patterns for suburbs in Riyadh and Mecca by analysing mortgage rates, population dynamics, and energy utilisation data (Alanzi, 2023).

Fraud Detection and Risk Management

Real estate companies utilise AI technology mainly to detect fraud cases while reducing associated risks. Real estate transactions face threats from problematic behaviours that involve inflated property valuations, document fraud, identity theft, and property deals between conspiring parties. AI-driven systems create a strong defence system by automatically detecting unusual patterns within enormous quantities of transaction data.

According to Ullah *et al.* (2018), machine learning tools using transaction and behavioural data recognise irregular patterns beyond normal legal and market standards, allowing fraud identification in the early stages. Pattern-recognition algorithms track active transactions through their monitoring system, yet they can also examine past transaction records to detect underlying system fraud patterns.

AI determines many lenders' present-day credit and mortgage risk evaluations. According to Gupta *et al.* (2022), ensemble learning models help institutions predict market downturns by reconstructing economic cyclicality, which allows them to adapt their exposure levels in advance. Risk assessment systems integrate dynamic variables, starting from interest rate modifications, unemployment patterns, and inflation patterns, and generate advanced market risk assessments compared to traditional static models.

AI-based fraud detection creates more than just operational speed benefits; it establishes transparency in financial operations, customer defence, and regulatory compliance requirements. The growing digitalisation sector makes real-time fraud surveillance using AI an upcoming requirement from regulatory bodies, instead of a competitive tool. In the Saudi real estate market, AI systems automatically monitor and adjust energy consumption in buildings, reducing waste and lowering costs. For example, machine learning algorithms optimise cooling loads based on occupancy, enhancing sustainability and aligning with national efficiency targets (Al-Baity, 2023).

Smart Property Management and Sustainability Applications

AI properties within property management constitute an essential component of recent innovation trends. Building intelligence achieves lower operational costs through predictive maintenance systems alongside tenant interaction bots that help optimise energy usage to enhance tenant satisfaction.

Integrating AI between life cycle cost estimation and Building Information Modelling (BIM) allows Khodabakhshian & Toosi (2021) to develop a framework that advances cost predictions and maintains proper planning. According to research results, predictive analytics demonstrates its ability to reduce capital expenses in the long run and guarantee uninterrupted service operations.

In parallel, Kempeneer *et al.* (2021) developed an AI framework that enables property operations to incorporate ESG metrics through their method. Real-time data analysis enables monitoring sustainability indicators, including energy usage, emissions, and water consumption. Implementing automated ESG performance auditing through AI will influence upcoming real estate investment decisions because environmental compliance has become an essential evaluator of real estate portfolio metrics. The Saudi Green Building Forum has partnered with AI start-ups to establish a system for sustainability auditing new commercial towers in the King Abdullah Financial District and evaluating

the property's energy profile. Integrating BIM technology with intelligent energy dashboards in NEOM residential blocks is part of the tests for achieving Vision 2030's net-zero targets (Aldhaen, 2024).

Implementing AI-powered systems through virtual assistants and leasing bots delivers personalised experiences at scale, enhancing the quality of service and lowering managerial demands. AI is a dual analytic solution and experience enhancement tool that helps achieve sustainable building goals through these diverse tools.

Challenges, Limitations, and Future Research Opportunities

Many continuous hurdles block the complete fulfilment of AI solutions throughout real estate applications. Numerous studies mention the interpretability of AI models as a common issue. High-accuracy Random Forest and XGBoost models suffer from a complex nature that reduces transparency. According to Dimopoulos and Bakas (2019) and Zurada *et al.* (2011), stakeholders need model interpretation capabilities to trust AI systems, particularly when regulatory oversight or public funding requirements exist.

Data quality excellence and input data diversity represent significant challenges in these systems. Koch *et al.* (2020) demonstrate the challenges of fusing unprocessed visual materials with numerical database elements because this approach produces irregular prediction results across geographic areas or sales divisions. The distributed state of real estate data infrastructure prevents portable model applications because information resides in separate agency and platform systems.

More studies should focus on ethical points on privacy issues alongside algorithmic bias determination. The essential nature of data governance standards increases with artificial intelligence systems that process sensitive financial and demographic data, for they need fairness testing and compliance checks.

Relevant studies must prioritise three areas: explainable AI techniques, multi-modal learning systems, and model distribution methods for protecting data privacy. Benchmarking research must be developed under existing conditions to enable cross-cultural and regulatory model comparisons for worldwide application.

CONCLUSION

A systematic literature study identified how Artificial Intelligence (AI) and Machine Learning (ML) technologies affect real estate property value forecasting and risk handling operations. Research on fifteen high-quality global academic studies shows that AI and ML technologies replace traditional valuation models because they deliver better prediction, flexible application, and extended data processing capabilities.

The ensemble learning techniques XGBoost, Gradient Boosting, and Random Forest achieved better results than typical property valuations performed through regression. The models demonstrated better predictive performance and adaptability with diverse property information containing spatial data, temporal data, visual features, and economic aspects. Real estate market optimisation needs this benefit since dynamic markets exhibit rapidly changing and non-linear price elements.

The reviewed findings display how AI solutions serve crucial functions in real estate domains by examining threats, helping investors make plans, identifying fraud, and enhancing smart estate administration methods. AI detection abilities and market prediction analytics make up the distinctive feature of AI algorithms, including macroeconomic trend simulation functionalities. AI is an investigative tool to detect fraudulent activities based on various research studies about transaction protection and institutional trust enhancement.

Moreover, AI is taking the property management sector into a new, astute automated system development generation. AI enhances profit and sustainability through its integration with Building Information Modelling and ESG tracking systems and energy monitoring, thus providing better tenant satisfaction. The real estate market benefits from innovative operational improvements through predictive factory servicing and tenant-lite chat programs, which transform property management standards.

However, challenges persist. The technology faces implementation hurdles because of concerns about model disclosure, separate data sources, privacy violations, and stakeholder resistance. Black-box models create trust challenges and technical barriers to model deployment between distinct market domains. These obstacles require scientists to conduct ongoing studies in explainable AI, ethical governance mechanisms, and standardised data pipelines.

In conclusion, Property valuation through AI and ML provides a robust data-oriented framework to analyse risks, which will transform real estate market operations. These technologies can transform built environment value creation by receiving proper oversight, creating transparent technical features, and establishing comprehensive adoption policies.

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Appendix

No.	Study Title	Authors	Year	ML Techniques Used	Dataset & Region	Key Findings
1	AI-Based Machine Learning Methods for Urban Real Estate Prediction: A Systematic Survey	Tekouabou *et al.*	2024	Various ML algorithms	Urban real estate datasets	Comprehensive overview of AI/ML techniques applied to urban real estate prediction, highlighting potential challenges and future directions.
2	A Systematic Review of Smart Real Estate Technology	Ullah *et al.*	2018	Various digital technologies, including AI/ML	Global studies	Explores factors influencing the adoption of digital technologies in real estate, including AI and ML, and discusses associated challenges.
3	Residential Real Estate Valuation Framework Based on Life Cycle Cost by BIM	Toosi	2021	Integration of AI techniques with BIM	Residential properties	Presents a framework integrating Building Information Modeling (BIM) with life cycle cost analysis for residential real estate valuation, incorporating AI techniques.
4	Machine Learning Predictions of Housing Market Synchronization Across US States	Gupta *et al.*	2022	Machine learning models	US housing market data	Investigates how machine learning models can predict housing market synchronisation across different states, considering economic uncertainty.
5	Multicriteria Analysis and Genetic Algorithms for Mass Appraisals in the Italian Property Market	Morano *et al.*	2018	Genetic Algorithms, Multicriteria Analysis	Italian property market	It applies multicriteria analysis and genetic algorithms to mass appraise properties, demonstrating the effectiveness of AI in property valuation.
6	Real Estate Image Analysis: A Literature Review	Koch *et al.*	2020	Computer vision techniques	Various real estate image datasets	This paper examines the use of image analysis and computer vision techniques in real estate, highlighting their role in property assessment and valuation.

7	Bringing the User Back in the Building: An Analysis of ESG in Real Estate	Kempeneer *et al.*	2021	Behavioral frameworks, ESG analysis	Real estate industry	Discusses the integration of Environmental, Social, and Governance (ESG) factors in real estate, emphasising the role of AI in enhancing sustainability assessments.
8	Impact of Rail Transit Station Proximity to Commercial Property Prices	Berawi *et al.*	2020	Big data analytics, ML models	Urban commercial properties	Using big data analytics and machine learning models, it analyses how proximity to rail transit stations affects commercial property prices.
9	Forecasting House Prices in OECD Economies	Marfatia	2018	Machine learning techniques	OECD countries housing data	Employs machine learning techniques to forecast house prices across OECD countries, demonstrating the models' predictive capabilities.
10	Mass Appraisal of Residential Real Estate Using Multilevel Modelling	Arribas *et al.*	2016	Multilevel modeling	Residential properties	It applies multilevel modeling to the mass appraisal of residential properties, highlighting the advantages of hierarchical models in real estate valuation.
11	A Comparison of Regression and Artificial Intelligence Methods in a Mass Appraisal Context	Zurada *et al.*	2011	Regression analysis, AI methods	Real estate appraisal datasets	Compares traditional regression methods with AI techniques in mass appraisal, demonstrating the superior performance of AI models in specific contexts.
12	Sensitivity Analysis of Machine Learning Models for the Mass Appraisal of Real Estate	Bakas	2019	Various ML models	Residential units in Nicosia, Cyprus	Conducts a sensitivity analysis of various machine learning models applied to mass appraisal, providing insights into model robustness and reliability.
13	Using Ensemble Methods of Machine Learning to Predict Real Estate Prices	Viktor Khomyshyn	2025	Gradient Boosting, Random Forest, Extra Trees	Real estate datasets	Explores the effectiveness of ensemble machine learning methods in predicting real estate values, with Gradient Boosting Regressor achieving the best performance.

14	Towards Robust and Speculation-Reduction Real Estate Pricing Models	Vargas-Calderón & Camargo	2020	Machine learning models	Bogotá, Colombia housing data	Proposes a data-driven real estate pricing model aimed at reducing human bias and speculation in property valuations, demonstrating robust and accurate price estimations.
15	Predicting Housing Prices and Analyzing Real Estate Market in the Chicago Suburbs	Xu & Nguyen	2022	Linear Regression, SVR, Decision Trees, XGBoost	Naperville/ Bolingbrook, Chicago housing data	It focuses on predicting housing prices using various machine learning models. XGBoost outperforms others in predictive accuracy and provides insights into factors influencing housing prices.