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A Review of Enabling Technologies Applied to Real Estate Pricing

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Uma revisão das tecnologias habilitadoras aplicadas à precificação de imóveis

RESUMO

Objetivo - Compreender como as tecnologias habilitadoras têm sido aplicadas na precificação imobiliária por meio de uma revisão sistemática da literatura, mapeando métodos, aplicações e tendências na engenharia de avaliações imobiliárias.

Metodologia - Foi conduzida uma Revisão Sistemática da Literatura (RSL), seguindo o protocolo PRISMA, com buscas em bases de dados relevantes como Science Direct, Scopus, Web of Science, entre outras, utilizando uma string de busca com operadores booleanos. Um total de 55 artigos publicados entre 2014 e 2024 foram analisados.

Originalidade/relevância - Sistematização dos artigos científicos produzidos nos últimos 10 anos sobre o uso de tecnologias emergentes em avaliação imobiliária, destacando o contraste entre os métodos tradicionais e as novas abordagens baseadas em inteligência artificial.

Resultados - A maioria dos estudos ainda adota métodos tradicionais de avaliação, mas há um uso crescente de tecnologias habilitadoras como aprendizado de máquina e geoprocessamento. A China lidera em número de publicações. A maior parte dos estudos concentra-se em investimentos imobiliários (49%), seguida do planejamento urbano. A aplicação de inteligência artificial melhora a precisão e reduz a incerteza na tomada de decisão imobiliária.

Contribuições teóricas/metodológicas - Os resultados contribuem para o avanço teórico da engenharia de avaliações e oferecem insights práticos para construtoras, incorporadoras, órgãos públicos e agentes de mercado ao indicar tendências metodológicas e tecnológicas promissoras para análise de valores imobiliários.

Contribuições sociais e ambientais - Do ponto de vista social, ao aprimorar a precisão na avaliação de imóveis, cria-se uma base mais confiável para políticas públicas habitacionais e urbanas, possibilitando que governos, construtoras e incorporadoras alinhem seus projetos às reais necessidades da população. Estudos que associam variáveis ambientais estimulam o planejamento urbano orientado para a sustentabilidade, contribuindo para o uso racional do solo, para a valorização de áreas com infraestrutura ecológica e para a redução de impactos ambientais negativos.

PALAVRAS-CHAVE: Avaliação Imobiliária. Tecnologias Habilitadoras. Aprendizado de Máquina. Mercado Imobiliário. Precificação.

A Review of Enabling Technologies Applied to Real Estate Pricing

ABSTRACT

Objective – To understand how enabling technologies have been applied to real estate pricing through a systematic literature review, mapping methods, applications, and trends in real estate appraisal engineering.

Methodology – A Systematic Literature Review (SLR) was conducted following the PRISMA protocol. Searches were carried out in relevant databases such as Science Direct, Scopus, and Web of Science, using a search string with Boolean operators. A total of 55 articles published between 2014 and 2024 were analyzed.

Originality/Relevance – This study systematizes scientific articles published over the last ten years on the use of emerging technologies in real estate appraisal, highlighting the contrast between traditional methods and new approaches based on artificial intelligence.

Results – Most studies still rely on traditional valuation methods, but there is a growing use of enabling technologies such as machine learning and geoprocessing. China stands out as the country with the largest number of publications. Regarding applications, real estate investment studies predominate (49%), followed by urban planning. The application of artificial intelligence improves accuracy and reduces uncertainty in real estate decision-making.

Theoretical/Methodological Contributions – The findings contribute to the theoretical advancement of real estate appraisal engineering and provide practical insights for developers, construction companies, public agencies, and market agents by pointing out promising methodological and technological trends for property value analysis.

Social and Environmental Contributions – From a social perspective, improving accuracy in property valuation strengthens the information base for housing and urban public policies, allowing projects to be better aligned with the real needs of the population. From an environmental standpoint, studies that incorporate ecological variables

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foster sustainable urban planning, encourage the rational use of land, enhance the value of areas with green infrastructure, and contribute to reducing negative environmental impacts.

KEYWORDS: Real Estate Appraisal; Enabling Technologies; Machine Learning; Real Estate Market; Pricing.

Una Revisión de las Tecnologías Habilitadoras Aplicadas a la Valoración de Inmuebles

RESUMEN

Objetivo – Comprender cómo las tecnologías habilitadoras se han aplicado a la valoración inmobiliaria a través de una revisión sistemática de la literatura, mapeando métodos, aplicaciones y tendencias en la ingeniería de valoraciones inmobiliarias.

Metodología e llevó a cabo una Revisión Sistemática de la Literatura (RSL), siguiendo el protocolo PRISMA. Las búsquedas se realizaron en bases de datos relevantes como Science Direct, Scopus y Web of Science, utilizando una cadena de búsqueda con operadores booleanos. En total, se analizaron 55 artículos publicados entre 2014 y 2024.

Originalidad/Relevancia – El estudio sistematiza los artículos científicos producidos en los últimos diez años sobre el uso de tecnologías emergentes en la valoración inmobiliaria, destacando el contraste entre los métodos tradicionales y los nuevos enfoques basados en inteligencia artificial.

Resultados – La mayoría de los estudios aún adoptan métodos tradicionales de valoración, aunque se observa un uso creciente de tecnologías habilitadoras como el aprendizaje automático y el geoposicionamiento. China se destaca como el país con mayor número de publicaciones. En cuanto a las aplicaciones, predominan los estudios sobre inversión inmobiliaria (49%), seguidos por la planificación urbana. La aplicación de la inteligencia artificial mejora la precisión y reduce la incertidumbre en la toma de decisiones inmobiliarias.

Contribuciones Teóricas/Metodológicas – Los resultados contribuyen al avance teórico de la ingeniería de valoraciones inmobiliarias y ofrecen aportes prácticos para promotores, constructoras, organismos públicos y agentes del mercado, al señalar tendencias metodológicas y tecnológicas prometedoras para el análisis de valores inmobiliarios.

Contribuciones Sociales y Ambientales – Desde el punto de vista social, la mejora en la precisión de la valoración inmobiliaria fortalece la base de información para las políticas públicas de vivienda y urbanismo, permitiendo alinear proyectos con las necesidades reales de la población. Desde la perspectiva ambiental, los estudios que integran variables ecológicas fomentan la planificación urbana sostenible, promueven el uso racional del suelo, valorizan áreas con infraestructura verde y contribuyen a la reducción de impactos ambientales negativos.

PALABRAS CLAVE: aloración Inmobiliaria; Tecnologías Habilitadoras; Aprendizaje Automático; Mercado Inmobiliario; Valoración.

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1 INTRODUCTION

The construction sector is capable of stimulating the economy through the mobilization of multiple segments of society. According to the Brazilian Chamber of the Construction Industry (CBIC), in 2022 the construction sector accounted for 6.8 percent of Brazil's Gross Domestic Product (GDP) (CBIC, 2023). Studying the real estate market is essential to support decision making in the context of the local economy by anticipating consumer behavior, assessing business feasibility, and identifying the factors that influence sale price formation, given the high cost, heterogeneity, immobility, and durability of real estate assets.

Amaral et al. (2022) emphasized that the real estate market exhibits characteristics that add complexity to forecasting trends relevant to construction-sector entrepreneurs. This complexity intensifies when one considers that housing quality is deeply intertwined with the urban conditions in which a dwelling is located, as demonstrated by Sperandio, Rodrigues and Vitarelli (2025). The authors show that socioeconomic and spatial factors such as income and infrastructure shape both habitability and property appreciation. Consequently, market dynamics, driven by long-term variability and sensitivity to fluctuations in the economic and social system, require extensive analyses with specific modeling approaches to avoid uncertain predictions.

The price of a property can be determined through various methods, with comparison to similar properties being one of the most widely used approaches (Gonzáles, 2002). The price a potential buyer is willing to pay for a specific property can be of great interest to developers because it supports cost–benefit analyses as well as the development and implementation of housing and urban policies, given that consumer preferences shape the conFiguretion of cities (Dantas, Magalhães and Vergolino, 2007).

Traditional methods such as the hedonic price model with linear regression are well established in the market. Morena et al. (2021) used the hedonic price model to analyze transactions and variables influencing property prices in Milan. Del Giudice et al. (2017) applied the same method to identify the influence of noise pollution on property prices. In addition to the variables commonly employed in predictive real estate pricing models, recent studies reinforce the importance of incorporating attributes related to housing quality as determinants of property value. Prudêncio, Salcedo and Pasquotto (2025) show that aspects such as thermal, acoustic, and lighting performance, as well as accessibility and functionality, directly influence residents' well-being and, consequently, their perception of a dwelling's value. Some studies have identified the relevance of spatial factors in real estate analysis and have integrated territorial information tools based on Geographic Information Systems (GIS) into geographically weighted regression models (Locurcio et al., 2020).

With technological advances and the increasing availability of data, artificial intelligence techniques have been incorporated into models to achieve greater accuracy. Machine Learning is an artificial intelligence technique used to identify, interpret, and analyze tabular data (Rampini and Re Cecconi, 2022). Using 245,517 observations, Elnaeem Balila and Shabri (2024) conducted a comparison of eight machine learning algorithms to predict property prices in Dubai.

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2 OBJECTIVE

In light of the above, the objective of this study is to understand how enabling technologies are being employed in appraisal engineering through a Systematic Literature Review in order to support decision making in the real estate sector by analyzing the applications and methods used.

3 METHODOLOGY

The research consisted of conducting a literature review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology.

The keywords used in the search were evaluation engineering, artificial intelligence, and real estate market. Combined with the Boolean descriptors OR and AND, they yielded the following search string: ("Evaluation engineering" OR "Assessment engineering") AND ("real estate market") AND ("Artificial intelligence" OR AI). Articles were collected from relevant databases with broad coverage and high reliability across multiple disciplines, including engineering. These databases included Science Direct, Scopus, Engineering Village, Ingenta, Sage, and Web of Science.

For article selection, only journal articles written in English that contained the search string in the title and/or abstract and/or keywords and were published between 2014 and 2024 were considered. Duplicates and articles not published in peer-reviewed journals were excluded. Subsequently, articles without full-text access and those related to construction cost or sustainability assessment were removed because they did not align with the focus of this study.

In the identification stage, 835 articles were initially found, as shown in Figure 1. After applying the selection criteria of excluding articles not published in journals, not published in English, and not published in the past ten years, the number was reduced to 420. Title screening revealed that many articles addressed topics from other research fields that were not relevant to this study, resulting in 236 exclusions. An additional 20 duplicate articles were removed. After reading the abstracts, 86 articles were discarded because their content was not related to the focus of this review. Subsequently, 78 articles were read in full and 55 were selected for inclusion. These articles presented relevant discussions on the pursuit of greater accuracy in real estate pricing and were therefore included in this review.

The PRISMA flowchart presented in Figure 1 was developed to illustrate the entire selection process applied in the review.

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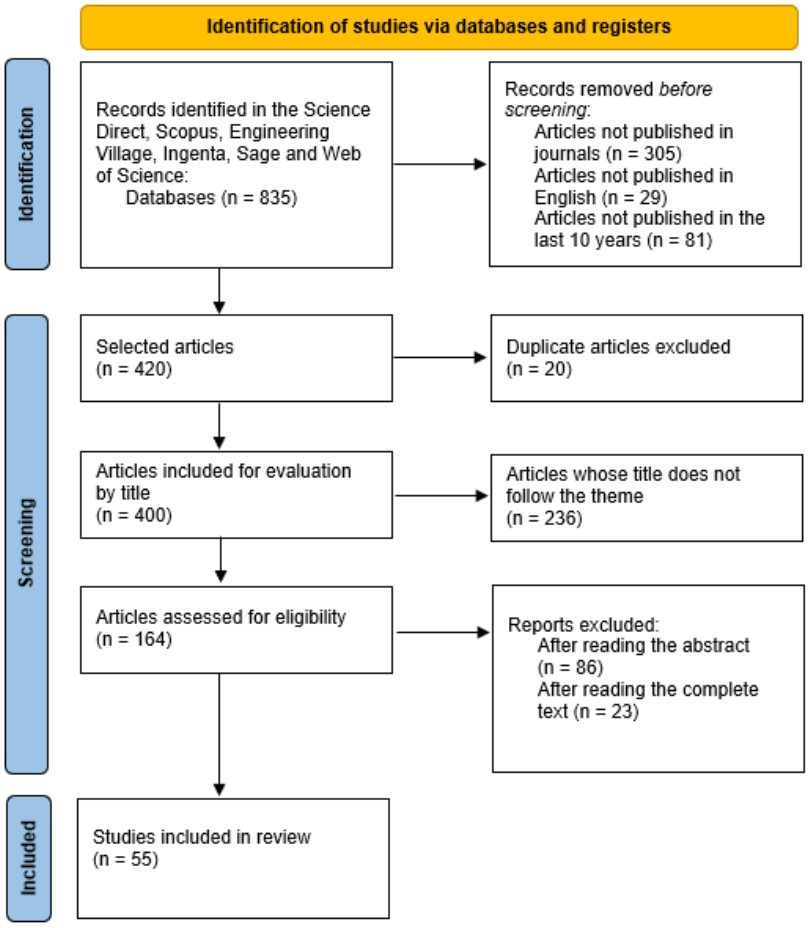
Figure 1 –Prisma Flowchart



Source: Authors (2025)

4 RESULTS AND DISCUSSION

Based on the analysis of the 55 selected articles and considering the country of the first author, it was possible to identify the prominent role of China in developing research related to the use of enabling technologies in real estate pricing. China accounted for approximately 24 percent of the studies reviewed, as shown in Figure 2.

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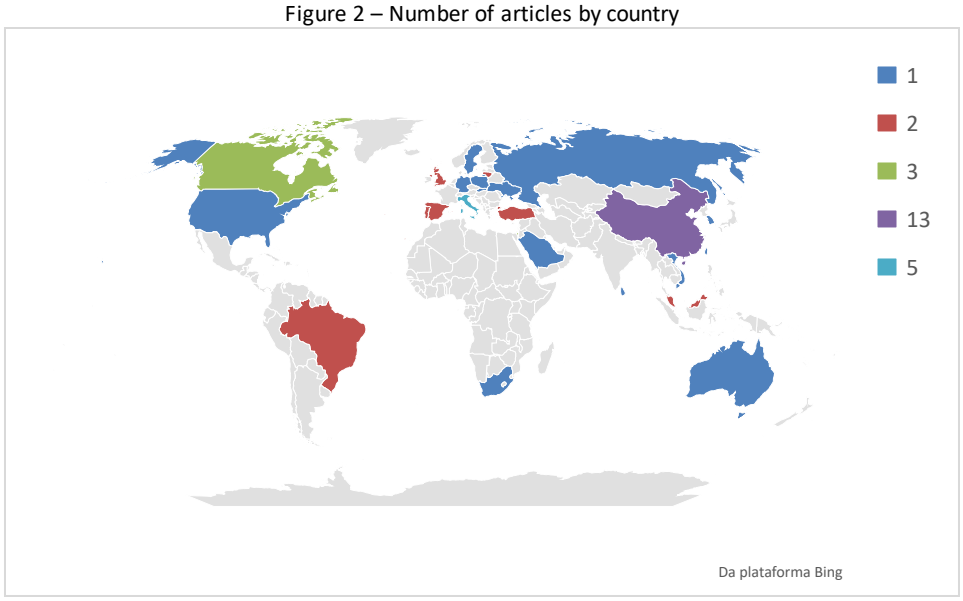
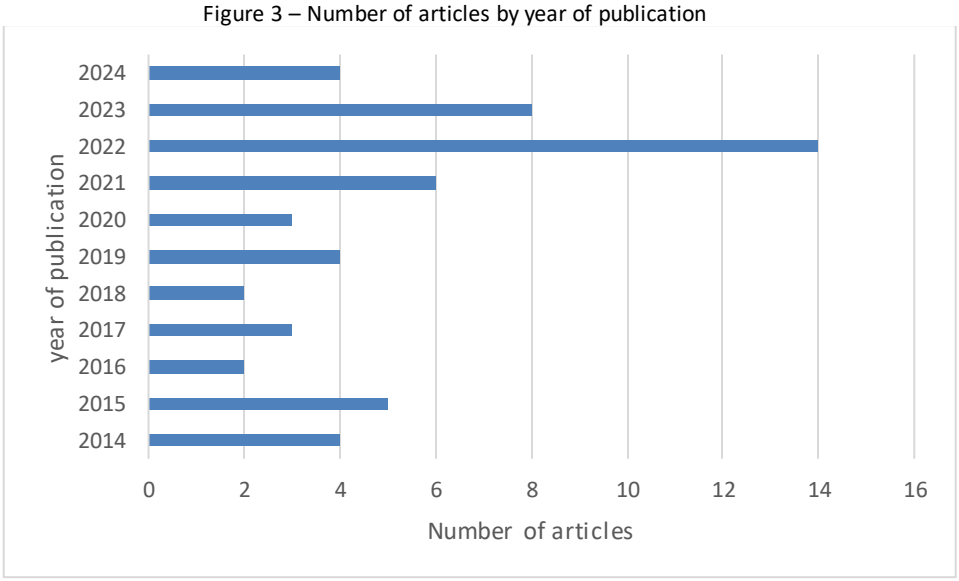
Figure 2 – Number of articles by country



Source: Authors (2025)

Among the articles reviewed, Figure 3 shows the number of publications over the past ten years. The year 2022 stands out with 14 published articles, followed by 2023 and 2021 with 8 and 6 publications, respectively.

Figure 3 – Number of articles by year of publication



Source: Authors (2025)

By analyzing the number of articles obtained from each database, as shown in Figure 4, it was possible to assess the effectiveness of each platform in relation to the research topic. Web of Science was the database with the highest qualitative yield, accounting for 55 % of the selected studies, followed by Science Direct with 31 %.

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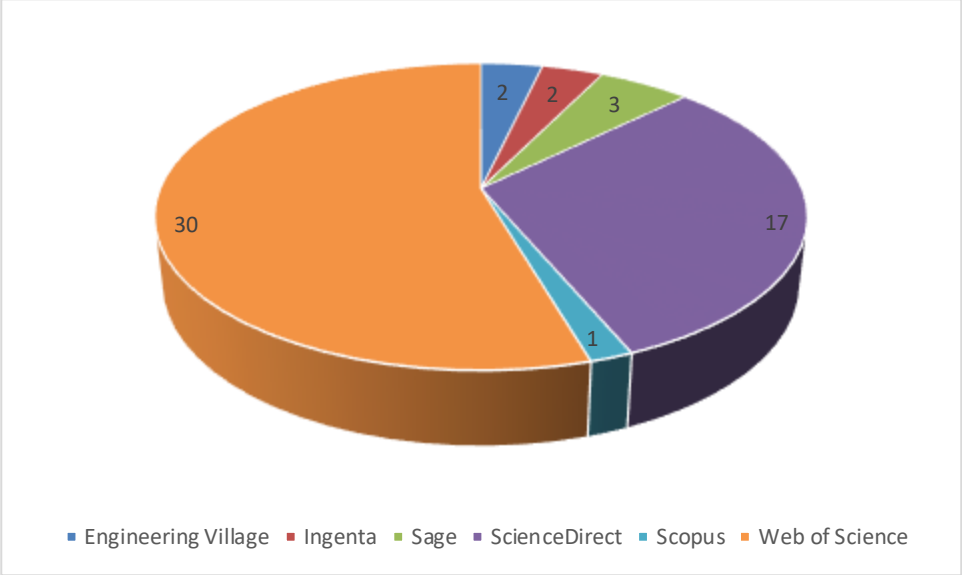
Figure 4 – Number of articles by database



Source: Authors(2025)

In the literature analysis, several themes emerged as central to studies on real estate appraisal. Using the real estate market as the primary field of investigation, the research focuses on examining market dynamics to support decision making in various contexts and applications. These applications may involve urban planning, real estate investment, financial institutions, and tax authorities. The applications were then related to the methods used to calibrate predictive pricing models, which are summarized in Table 1. The review showed the use of both traditional methods and machine learning methods based on artificial intelligence .

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Table 1 – Frequency distribution of the main application fields of the articles.

Application field	Traditional methods	Methods based on artificial intelligence
Financial Market	Tupenaite et al., 2017 Grybauskas; Pilinkienė, 2018 Shimbo et al., 202danta0 Katzler, 2016 Heinig; Nanda; Tsolacos , 2020	Tajani et al., 2019 Wang, X. et al., 2022
Real Estate Investment	Bartoněk; Dermeková, 2015 Hubar et al., 2023 Locurcio et al., 2020 Morena et Al., 2021 Mwanyepedza; Mishi, 2024 Nguyen et Al., 2023 Plante, 2022 Rathnayake; Pushpakumara, 2023 Soares et al., 2022 Ullah et al., 2021 Durica et al., 2018 Eng, 2023 Hong, 2014	Baur et al., 2023 Elnaeem Balila; Shabri, 2024 Fernández et al., 2015 Kamara et al., 2020 Kim et al., 2021 Mora-Garcia et al., 2022 Rizun; Baj-Rogowska, 2021 Tekin; Sari, 2022 Wang X et al., 2014 Zhan et al., 2023 Del Giudice et al., 2019 Gerek, 2014 Hromada, 2015 Tasi et al., 2017
Urban planning Urban planning	Chen et al., 2022 Erdoğan; Memduhoğlu, 2019 Li et al., 2019 Martins et al., 2015 Shani, 2023 Yaagoubie et al., 2021 Yu et al., 2023 Zhao et al., 2024 Feng et al., 2022 Han et al., 2022 Zhitomirsky-Geffet; Maman, 2014	Arefiev et al., 2015 Hromada, 2016 Wang, Z. et al., 2022
Construction and development companies	Bin et al., 2023 Del Giudice et al., 2017 Lou et al., 2024	Alvarez et al., 2022 Amaral et al., 2022
Tax authorities	Sayag et al., 2022	Fu, 2022

Source: Authors (2025)

With the articles grouped by application field, it was possible to analyze their distribution proportions, as shown in Figure 5. Approximately 49 percent of the articles focus on real estate investment, with the frequency gradually decreasing across the remaining categories, reaching the tax field, which accounts for only 4 percent of the studies reviewed.

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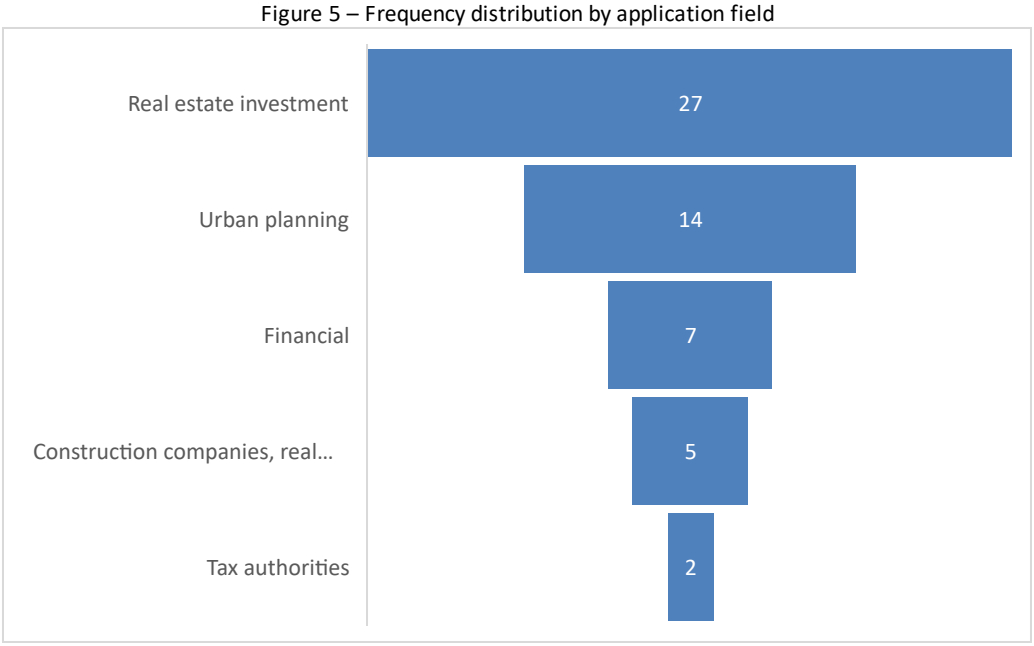
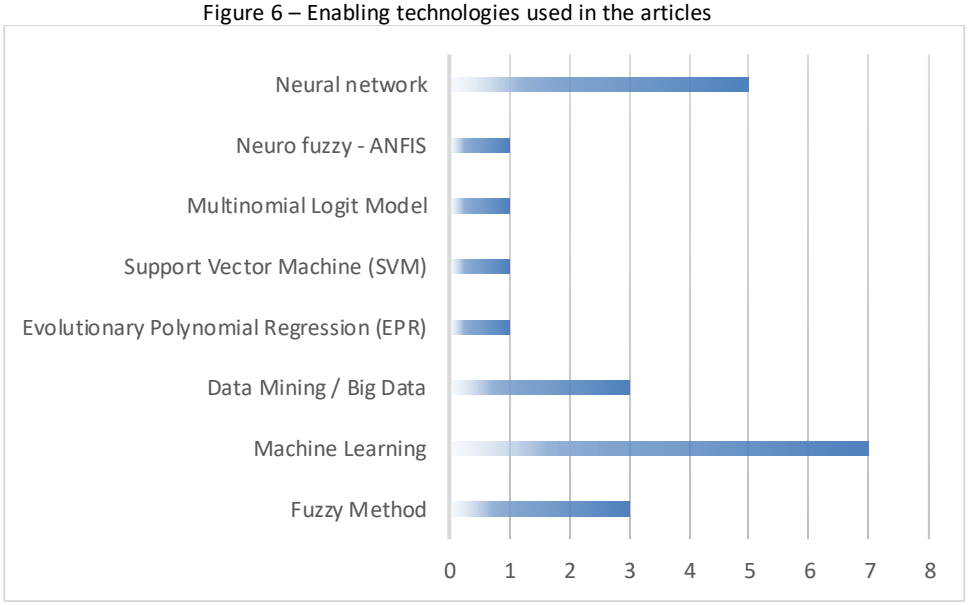
Figure 5 – Frequency distribution by application field



Source: Authors (2025)

The application of artificial intelligence varies according to the purpose of the study and the amount of data available. Among the selected articles, 40 percent employed enabling technologies in their analyses, while 60 percent relied on traditional methods. Of the 22 articles that adopted enabling technologies, seven applied machine learning techniques. Five authors opted for the use of neural networks, and Wang, Z. et al. (2022) combined neural networks with geographically weighted regression. These were followed by Big Data or Data Mining approaches and fuzzy methods, each represented in three articles, as shown in Figure 6.

Figure 6 – Enabling technologies used in the articles



Source: Authors(2025)

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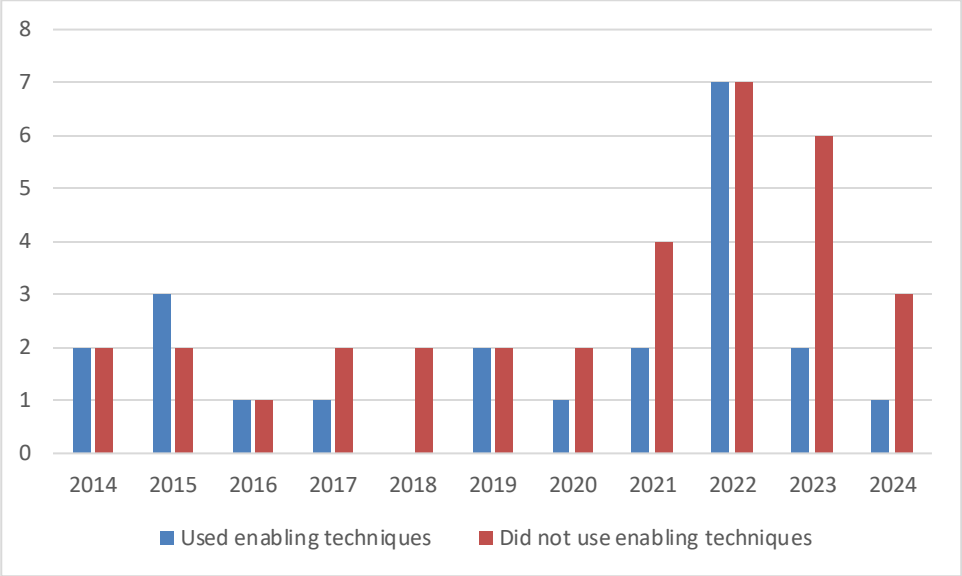
Traditional methods remain solid alternatives for analyzing the real estate market. Their application continues to support decision making across various real estate sectors, with the highest incidence observed in urban planning studies. Enabling technologies, however, are still not widely disseminated in the literature, and their applicability fluctuated throughout the study period. Figure 7 shows that in 2022 there was an equal number of publications using traditional methods and publications employing enabling technologies.

Figure 6 – Enabling technologies used in the articles



Source: Authors (2025)

3.1 Financial Market

Socioeconomic agents have a direct relationship with the real estate market and the pricing of its assets. Tajani et al. (2019) analyzed the impact of socioeconomic variables on residential property prices in Spanish cities. Using evolutionary polynomial regression, they developed a methodology to predict future trends and monitor real estate bubbles. Grybauskas and Pilinkienė (2018) employed matrix factorization to study real estate market stability with the aim of developing a bubble index to offer insights into current market conditions. Because the real estate market is sensitive to economic fluctuations, Tupenaite, Kanapeckiene, and Naimaviciene (2017) identified the main determinants of real estate fluctuations in Lithuania. Using the Analytic Hierarchy Process (AHP), their study revealed that interest rates, new mortgage loans, and inflation are the economic factors with the greatest influence on the Lithuanian market.

Macroeconomic conditions affect financing decisions, and models based on traditional methods have difficulty producing accurate predictions due to the rapid expansion of data collection and the development of information technology (Wang, X. et al., 2022). In their study, the authors proposed analyzing the accuracy and interpretability of short-term macroeconomic forecasting by applying the N-BEATS neural network, achieving results superior to traditional methods. In Brazil, in 2020, Shimbo et al. investigated how international real estate consultancies influence the financialization of the real estate market in the city of São Paulo using discounted cash flow analysis. Katzler (2016) compared the efficiency of real

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estate portfolio diversification strategies. Using methods distinct from classical statistics, the author evaluated diversification strategies based on property types and regions to adjust risk and enhance returns.

3.2 Real Estate Investment

Real estate investors must consider multiple criteria during the decision-making process. Market trends, buyer needs, and market outlook are key elements that must be analyzed in order to understand the demands of the real estate sector (Soares et al., 2022). Depending on the purpose of the valuation and the information available, different appraisal methods are employed. Whether using traditional mathematical and statistical models or incorporating artificial intelligence, a wide range of factors must be evaluated in market analysis. Table 2 presents several methodologies applied in different research contexts.

Table 2 – Methods and propositions of articles related to real estate investment.

Reference	Methods used	Proposition
Bartoněk; Dermeková, 2015	Multicriteria analysis	Apply decision-making theory within the context of business geography, specifically in the real estate market, with the aim of optimizing input data and selecting the best alternative through spatial decision strategies.
Hubar et al., 2023	Matrix pseudo-inversion	Determine the market value of properties using advanced mathematical methods in order to minimize evaluator subjectivity.
Locurcio et al., 2020	Geographically weighted regression model	Contribute to the debate on the use of Automated Valuation Models (AVMs) by defining and testing a valuation model for corporate properties
Morena et al., 2021	Hedonic pricing model	Identify and forecast future scenarios of the residential real estate market in the city of Milan, taking into account the socioeconomic and spatial characteristics that affect the market value of properties.
Mwanyepedza; Mi-shi, 2024	Ordinary least squares and quantile regression	Investigate the existence of the endowment effect in the real estate market, specifically in the context of South Africa, and examine whether the disclosure of information can reduce the disparity between willingness to pay (WTP) and willingness to accept (WTA).
Nguyen et al., 2023	Spherical fuzzy set	Identify the critical factors that influence consumer choices when selecting apartments and assess the main providers in the real estate market, especially in developing countries such as Vietnam.
Plante, 2022	Qualitative methods	Examine price formation in the real estate market by exploring the valuation process and the mediation of different factors, such as calculations and emotional attachments, that influence the value attributed to properties.
Rathnayake; Pushpakumara, 2023	Analytic Hierarchy Process	Analyze and rank the factors that directly affect the valuation of residential buildings by developing a model based on priority weights.
Soares et al., 2022	Value Focused Thinking (VFT) and the Best Worst Method (BWM)	Develop a multicriteria evaluation model to support decision making in large real estate investments, taking into account multiple criteria and variables.
Ullah et al., 2021	DEMATEL	Explore user perceptions of online real estate platforms and identify the critical factors that shape these perceptions.
Eng, 2023	Qualitative analysis	Provide a comprehensive overview of the transformations that are reshaping the real estate sector in the coming years, focusing

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		on four main areas: the digital revolution, sustainability, real estate investment, and the new geography of investment in the sector.
Hong, 2014	Generalized Method of Moments (GMM)	Assess the dynamic relationship between real estate investment and economic growth in China by analyzing the short and long term effects of real estate investment.
Baur et al., 2023	Machine learning – Neural network	Investigate and evaluate how machine learning models can be used to predict property prices based on textual descriptions of the properties.
Del Giudice et al., 2019	Multinomial logit model	Present an integrated valuation model to support investment decisions in the residential real estate market, taking into account the factors that influence attractiveness.
Elnaeem Balila; Shabri, 2024	Machine learning	Conduct a comparative analysis of eight machine learning algorithms to predict real estate prices in Dubai.
Fernández et al., 2015	Machine learning – Fuzzy method	Examine Evolutionary Fuzzy Systems (EFSs), discussing their properties, challenges, and new trends in the context of data mining and fuzzy system optimization.
Gerek, 2014	Machine learning – Neuro Fuzzy (ANFIS)	Evaluate the accuracy of two neuro fuzzy approaches for forecasting prices in the real estate market and determine which of them offers better results.
Hromada, 2015	Machine learning – Data Mining	Identify hidden patterns in real estate market data that can help forecast prices and explain regional variations.
Kamara et al., 2020	Machine learning – Neural network	Propose a hybrid neural network model to predict the number of days a property will remain on the market, a key liquidity metric in the real estate sector.
Kim et al., 2021	Machine learning	Develop a method to automatically calibrate dynamically varying and heterogeneous parameters in agent based models (ABMs).
Tasi et al., 2017	Machine learning – Fuzzy method	Develop a model for property price appraisal using fuzzy based theory according to several factors and compare the results with recorded transactions to identify the main reasons for high prices.
Mora-Garcia et al., 2022	Machine learning	Identify the best machine learning algorithms for predicting housing prices and quantify the impact of the COVID 19 pandemic
Rizun; Baj-Rogowska, 2021	Machine learning	Investigate whether the intensity of internet search queries, based on the search volume index (SVI) from Google Trends, can predict changes in real estate market prices.
Tekin; Sari, 2022	Machine learning	Assess how different machine learning methods can improve the accuracy of real estate price prediction using a large housing market dataset from Istanbul
Wang et al., 2014	Support Vector Machine (SVM)	Improve the accuracy of price forecasts in the real estate market, taking into account data complexity such as nonlinearity and small sample sizes
Zhan et al., 2023	Machine learning	Develop and test an innovative framework for house price prediction. This framework uses hybrid machine learning models to enhance the accuracy and stability of real estate price forecasts.

Source: Authors (2025)

3.3 Urban Planning

Public policy makers are interested in understanding urbanization processes so that development can remain compatible with both human and environmental needs (Fang et al., 2021). The United Nations 2030 Sustainable Development Agenda states that by 2030 approximately 60 percent of the world's population will be living in urban areas (United Nations, 2015). Martins et al. (2015) contributed to strategic planning in the real estate sector

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in Lisbon by proposing a methodology to calculate time on the market for residential properties. Considering both tangible and intangible property characteristics, the authors used the Analytic Hierarchy Process (AHP) to develop a conceptually and empirically valid framework. Arefiev et al. (2015) demonstrated the feasibility of ranking land parcels in the suburbs of Saint Petersburg to support decision making in urban planning by applying the fuzzy set method.

An analysis of the literature reveals an increasing use of the geographically weighted regression (GWR) model as a tool to support real estate market analysis and urban planning. Chen et al. (2022) examined the spatial effect of infrastructure development on housing prices using the GWR model, finding that urban infrastructure significantly affected the real estate market. Using the same model, Erdogan and Memduhoglu (2019) analyzed the Turkish real estate market from 2004 to 2017. By identifying spatiotemporal patterns and sales clusters using Geographic Information Systems (GIS), their analysis provided insights for investment planning and economic policy in the country's real estate sector. Due to the Grand Mosque and the surrounding hospitality activities, the city of Makkah has experienced rapid urban and population growth (Yaagoubi et al., 2021). This growth prompted the authors to use GWR integrated with Voronoi diagrams to assess land values, given the construction trends accompanying urban development. Zhao et al. (2024), using GWR, found that rental housing prices decrease as the distance from Hefei's city center increases. Identifying such price influencing factors supports the formulation of urban policies and decisions regarding housing resource management. Wang, Z. et al. (2022) combined geographically weighted regression with neural networks and found that the hybrid approach delivered better predictive performance than traditional methods.

By administering questionnaires to 106 individuals, Shani (2023) analyzed interviews with homebuyers to investigate the practices and processes through which middle class consumers choose where to live. Based on the responses, the author was able to map urban spaces according to decision making patterns that involved both reflexivity and habitus. Feng et al. (2022) applied 92 questionnaires to assess residents' willingness to purchase housing in the province of Henan using the extension cloud model. The results indicated that the Chinese real estate market has undergone significant fluctuations in recent years. Han et al. (2022) proposed measures to promote harmonious development between urbanization and the real estate market through a coordinated growth simulation model analyzed systematically.

3.4 Construction and Development Companies

Real estate pricing is composed of multiple attributes that characterize a property, and by identifying these attributes it is possible to measure the consumer's willingness to pay for each characteristic. Therefore, the most effective way to measure consumer preferences is to analyze their purchasing behavior (Pinto and Fernandes, 2019).

Lou et al. (2024) sought to understand preferences for housing attributes related to well being and project layout, such as natural lighting autonomy, natural ventilation efficiency, and thermal comfort. By applying logarithmic regression to construct a hedonic model, the study found that property values increased when associated with natural lighting and

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ventilation, while thermal comfort did not show a satisfactory correlation. The study offered insights for the Hong Kong real estate market by prioritizing consumer preferences and highlighting market value drivers. Del Giudice et al. (2017) proposed an econometric analysis of real estate prices to assess how property values are affected by environmental quality. Conducting a case study on traffic noise along Naples' ring road, the authors applied a hedonic pricing model and found that noise pollution led to an average 4.16 percent reduction in residential property prices.

Amaral et al. (2022) provided insights for construction and development companies by identifying characteristics that influence the sales velocity of vertical residential developments in Goiânia and local market opportunities. Combining data mining, Big Data, and modeling techniques, the authors found that among the variables included in the model, the factors with the greatest influence were location, number of bedrooms, and private floor area. Properties smaller than 50 square meters represented the highest market opportunity. Spatial characteristics play a major role in price estimation. Alvarez et al. (2022) developed an incremental learning model based on decision trees to estimate lot prices. Bin et al. (2023) used matrix factorization to study the spatial and temporal impact on home pricing and forecast future prices. Despite employing different methodologies, both studies highlight the importance of spatiality in real estate price analysis and its relevance for decision makers in the real estate market.

3.5 Property valuation and the potential of property tax

Property tax has significant revenue potential in urbanized areas and represents an important financial resource for cities. Fu (2022) developed a model for assessing the real estate tax base using deep learning neural networks (DLNN) in China. Aiming to enhance the accuracy of valuation results, the model was tested and compared with other algorithms, demonstrating higher reliability and lower error in predicting property values. This approach facilitates large scale assessments within the context of the digital economy.

In Israel, the provisional House Price Index (HPI) is subject to revisions within short periods. Sayag et al. (2022) proposed a methodology to reduce revisions in hedonic house price indices in order to improve the accuracy of provisional indicators. With the support of a nowcasting model, the provisional HPIs showed success in reducing the magnitude of revisions.

4 CONCLUSION

An analysis of the literature on property valuation shows how broad its applications are across multiple sectors. The technical and scientific processes used to price real estate contribute directly to decision making in various fields of application. Extracting market information such as trends, the identification of potential real estate bubbles, or simply understanding the property characteristics most valued by consumers supports the feasibility of real estate projects. These analyses help investors determine which regions are likely to experience greater appreciation. Likewise, they support urban planning by assisting government agencies and planners in making decisions regarding land use regulations,

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infrastructure improvements, and the development of new areas, thereby promoting orderly territorial valorization.

Across the articles reviewed, enabling technologies were frequently applied to support the modeling process. Some studies demonstrated the use of Big Data to identify market patterns, while others employed geoprocessing tools to spatially analyze properties and their surroundings, resulting in a more precise understanding of how location influences price. Even though traditional methods remain widely used, several studies highlight artificial intelligence as an enabling tool for analyzing large data volumes. Machine learning has proven effective for automating valuation processes and improving the accuracy of property value estimates.

The use of artificial intelligence enables a more dynamic analysis of the market. These models provide greater consistency, reduce error margins, and offer stronger support for evidence based decisions and more reliable market forecasts. Accurate real estate valuation creates a more robust foundation for housing and urban public policies, enabling governments, construction companies, and developers to align their projects with the actual needs of the population. This contributes to democratizing access to housing, reducing inequalities, and supporting the development of more inclusive cities. Additionally, by identifying the socioeconomic factors that influence prices, the models help prevent real estate bubbles and protect families and investors from financial risks.

In this sense, enabling technologies not only promote innovation in the real estate sector but also offer essential tools for building more resilient, sustainable, and socially balanced cities.

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DECLARATIONS

AUTHOR CONTRIBUTIONS

When describing each author's participation in the manuscript, use the following criteria:

- **Conception and study design**: Larissa Kelly da Silva França Barbosa.
- **Data curation**: Larissa Kelly da Silva França Barbosa.
- **Formal analysis**: Larissa Kelly da Silva França Barbosa.
- **Funding acquisition**: Not applicable.
- **Investigation**: Larissa Kelly da Silva França Barbosa.
- **Methodology**: Larissa Kelly da Silva França Barbosa.
- **Writing – original draft**: Larissa Kelly da Silva França Barbosa.
- **Writing – review and editing**: Larissa Kelly da Silva França Barbosa.
- **Writing – final review and editing**: Larissa Kelly da Silva França Barbosa.
- **Supervision**: Emilia Rahnemay Kohlman Rabbani, Felipe Mendes da Cruz e Eliana Maria Gorga Lago

DECLARATION OF CONFLICTS OF INTEREST

We, **Larissa Kelly da Silva França Barbosa, Emilia Rahnemay Kohlman Rabbani, Eliana Maria Gorga Lago, and Felipe Mendes da Cruz**, declare that the manuscript entitled "**A review of enabling technologies applied to real estate pricing**":

1. **Financial ties:** There are no financial relationships that could influence the results or interpretation of the work. No institution or funding entity was involved in the development of this study.
2. **Professional relationships:** There are no professional relationships that could affect the analysis, interpretation, or presentation of the results. No professional relationship relevant to the content of this manuscript has been established.
3. **Personal conflicts:** There are no personal conflicts of interest related to the content of the manuscript. No personal conflict associated with the content has been identified.