
Reshaping the World with Computer Technologies and Their Impact on the Development of Processes in the Field of Real Estate Trading

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ABSTRACT

Purpose: This study examines artificial intelligence (AI) impact on real estate, highlighting its role in improving processes, enhancing customer experiences, and ensuring competitiveness while prioritising data protection and security.

Methodology/Approach: A comprehensive literature review compared AI technologies in real estate, including drones, the Internet of Things (IoT), cloud computing, big data, 3D scanning, wearables, virtual and augmented realities, and robotics. It examines their impact on operations, focusing on AI in Heating, Ventilation and Air Conditioning (HVAC) systems for energy efficiency and comfort.

Findings: AI enhances real estate development by optimising operations, transforming customer relationships, and improving energy efficiency and comfort with AI-controlled HVAC systems. Benefits include automated data processing, better decision-making, and optimised marketing strategies.

Research Limitation/Implication: AI has great potential, but its implementation is in the early stages, including in real estate. Challenges include data protection, security, costs, and new hardware for HVAC systems. Broader real-case testing is needed.

Originality/Value of paper: This paper broadens the perspective on AI's impact on real estate, showing how to implement AI in various processes. It improves performance and transforms customer experiences, setting new standards for property management.

Category: General review

Keywords: data processing development; real estate trade; artificial intelligence

Research Areas: Management of Technology and Innovation

1 INTRODUCTION

In the technology-driven age, the real estate industry is also being transformed by advanced Information Technologies (IT). The study seeks to evaluate how AI can be used to modify real estate operations, improve business processes, fundamentally improve construction processes related to Heating, Ventilation and Air Conditioning (HVAC) systems, and transform customer experiences at the same time.

This way, modern IT, mainly AI, may boost business models and change the process of construction within the real estate market. AI applications in HVAC are effective in energy use optimisation and offer more comfortable settings for clients. The way in which consumer welfare is enhanced is the fact that the mostly forward-looking processing of customers' and maintainers' demands are done in the most user-friendly and cost-effective way. The rise of AI-supported management systems for customer relations and targeted marketing proposes that firms can adjust their interface with their clients and enhance their contact and satisfaction. More specifically, AI-controlled heating, ventilation, and air conditioning systems not only propose more freedom for residents but also enhance energy use and, accordingly, offer a more comfortable and energy-efficient environment. The ideas are built upon through the explanation of drone usage, IoT, virtual reality (VR) and augmented reality (AR) for infrastructure and data security. These technologies encourage a strategic introduction of AI within the property market, thus making this market more attractive. It strengthens and gives the chance for further growth in business. This viewpoint is strengthened by abundant literature and case studies, which propose that the strategic usage of AI will be highly supportive of the positive enhancement of energy efficiency, comfort, and overall business function within the property market.

Other aspects of AI applications include company productivity, improved energy, and customer relationship management as well as marketing strategies, which this study deals with. AI solution approaches are needed not only for competitiveness and real estate market development but also for challenges related to data protection and data security. It is assumed that if AI and other innovative technologies are used in a targeted manner, new standards can be set in terms of quality and profitability in real estate management.

2 METHODOLOGY

Real estate needs to improve its adoption of disruptive technologies to move from traditional to smart real estate (SRE). This study reviews the adoption of disruptive technologies in real estate. It covers the applications of nine such technologies, hereby referred to as the Big9. These are drones, the Internet of Things (IoT), clouds, software as a service (SaaS), big data, 3D scanning, wearable technologies, virtual and augmented realities (VR and AR), and Artificial Intelligence (AI) and robotics (Ullah, Sepasgozar, Wang, 2018).

Mobile device

Mobile devices are primarily notebooks and their further development into tablet personal computers (PC) or mobile phones and their further development into smartphones that have access to the Internet via wireless data transmission, Wireless Local Area Network (WLAN) or Bluetooth.

Notebooks, Tablet, PCs and Smartphones

Over time, notebooks became faster and faster in data processing and had ever-larger hard disks and better graphics cards. Also, the notebooks became smaller and could now be carried more easily everywhere. Compared to conventional PCs, they are powered by accumulators (rechargeable batteries), whose performance constantly increases. This allows them to remain in operation independently of the power grid for a few hours. Here again, the "Moore's law" comes into effect. The notebooks became cheaper and cheaper and thus accessible to a broad mass. In 2003, Intel introduced a Pentium M processor Intel Centrino mobile technology specifically designed for mobile use with a more effective and economical operation. They were reshaping the World with Computer Technologies and their Impact on the Development of Processes in the Field of Real Estate Trading.

As a result, the wireless WLAN connection to the Internet became standard equipment on notebooks and Tablets (IT-techBlog, 2006). These developments have led to more and more people deciding to buy a notebook and Tablet. The development of sales figures for Germany is shown graphically in Figure 1.

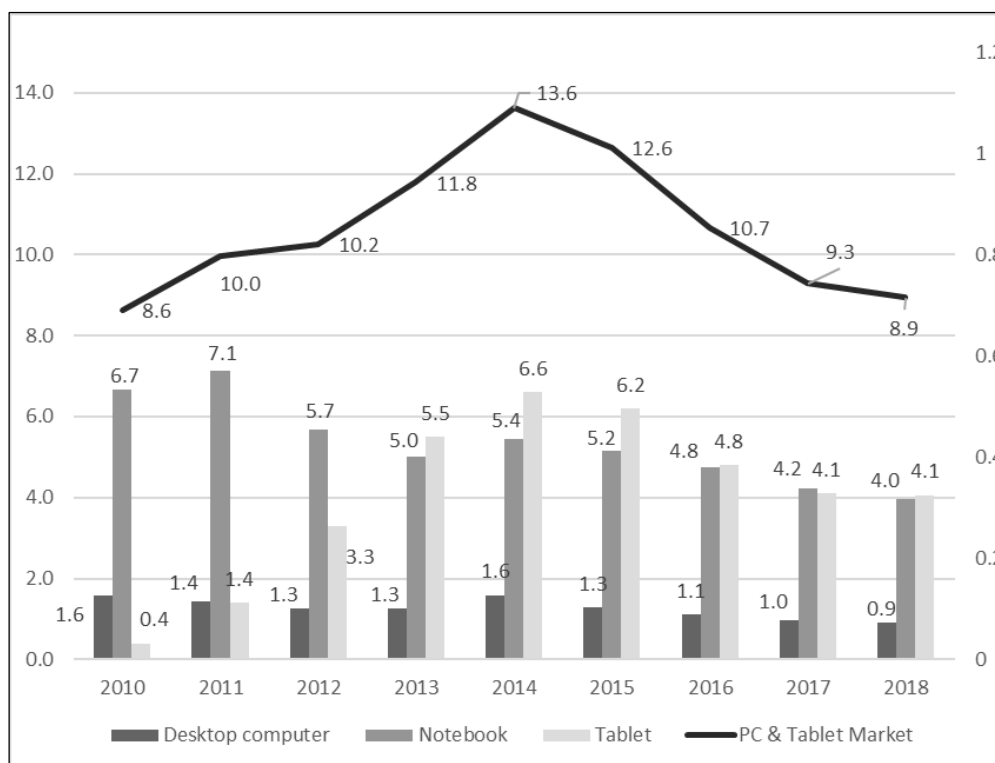


Figure 1 –Sales of desktop PCs, notebooks and Tablet PC in Germany – in millions of units (Statista GmbH (2019))

Virtual reality

Over the last few years, virtual reality technologies have been increasingly applied to various fields, from educational to medical to military contexts (Pleyers, Poncin, 2020). Azmi et al. (2022) published a significant difference in the atmosphere and house purchase intention between real and virtual environments. On the other hand, pleasure and arousal emotions evoked in real and virtual environments showed no significant difference. The results show that the atmosphere significantly affects pleasure and arousal, where pleasure, in turn, has a significant effect on purchase intention, and arousal showed an insignificant effect on purchase intention in the virtual environment.

Artificial intelligence

Disruptive technologies such as the Internet of Things, big data analytics, blockchain, and artificial intelligence have changed how businesses operate. Of all the disruptive technologies, artificial intelligence (AI) is the latest technological disruptor and holds immense marketing transformation potential. Practitioners worldwide are trying to figure out the best fit AI solutions for their marketing functions (Verma et al., 2021). Artificial intelligence (AI) is becoming widely recognised as a potential game-changer across industries, including real estate. Real estate technology, or property technology (prop-tech), is starting to have a broad impact on the mechanisms of the real estate industry, but we are in the early days, especially with regard to the possibilities for the changes that AI could bring (Viriato, 2019).

An increasing amount of research on Intelligent Systems/Artificial Intelligence (AI) in marketing has shown that AI can mimic humans and perform activities in an 'intelligent' manner (Vlačić et al., 2021). A flexible tool like artificial intelligence (AI) encourages innovation by providing data-driven insights, individualised marketing, and operational efficiencies (Arumugam et al., 2024).

Artificial intelligence in real estate forecasting

Forecasting is a major issue in most aspects of real estate practice. Valuation and appraisal are forecasting. Property development relies on forecasting expected costs and returns. Property and facilities managers use forecasts of supply and demand as well as of costs and returns. Funds and investment managers rely on forecasts of value now and in the future through forecasts of growth and economic activity. With all this forecasting being relied upon, it is somewhat surprising that the uses of AI and ES are primarily restricted to mass appraisal; however, this is less surprising when an analysis of the use suggests that most of this would fit better into the description of conventional programme systems. Early attempts at "automating" or "computer assisting" valuation go back as far as the late 1970s when sufficient computing power became available (Rossini, 2000).

According to Woubishet Zewdu Taffese (2006), real estate valuation is no longer a traditional business that relies only on expert opinions of value. The profession is now facing greater transformation in the valuation process and methodology,

along with innovations in information technology. Technology has a profound effect on the profession and influences the real estate valuation process, largely pressured by the needs of today's clients who demand quick, easy, and more objective processes to arrive at the opinion of value. The needs somehow motivate dependency on intelligent valuation system that allows clients to get faster and more accurate value (Taffese, 2006).

Upendar Rao Thaduri (2021) says that artificial intelligence and virtual reality transform our economy and lifestyles. The user adapts virtual reality to his demands over time. Virtual environments allow rooms to be discovered in places normally inaccessible owing to price, security, or perceived limits. AI and VR-based real estate app development benefits real estate professionals and consumers. AI-powered real estate apps help specialists judge by predicting market trends, property valuations, etc. Real estate brokers and clients save time and money by automating property inspections and showings with AI. Real estate apps using VR can give buyers an immersive and interactive home tour. VR technology lets purchasers experience properties as if they were there, helping them decide if they want it. AI/VR technology creates virtual walkthroughs of under-construction properties to show buyers the outcome. A real estate app with AI and VR enhances the experience. An AI-powered virtual agent may help buyers identify houses that meet their criteria, while a VR-powered virtual tour can immerse them in the property. AI/VR-based real estate apps can incorporate property search and comparison, property management, and real-time market updates. AI and VR-based real estate app development improves productivity, cost savings, and buying experiences (Thaduri, 2021).

Top 10 Use Cases of AI in Real Estate

The first of the many use cases of AI in the real estate market occurred in 2018, acquiring two properties in Philadelphia for \$26 million. The multi-family buildings were picked using an AI algorithm called "soon-to-market detection". Since then, AI and machine learning use cases in real estate have been growing exponentially, taking the industry to unprecedented heights. As AI and machine learning in real estate continue to make significant inroads, realtors use these intelligent systems in multiple ways, and the implications are profound. The "Top 10 Use Cases of AI in Real Estate" is shown graphically in Figure 2.



Figure 2 – Top 10 Use Cases of AI in Real Estate (Appinventiv, 2024)

Listing Descriptions Generation – AI can seamlessly automate the tedious and time-consuming task of listing descriptions.

Virtual Tour – With the rise of augmented and virtual reality in real estate, potential investors can get a realistic view of the property without even stepping foot on the site. Realtors can offer virtual tours to the buyers that give a true sense of how the space looks and feels.

Lead Generation – Lead flow is the lifeblood of any business, and real estate is no exception. AI helps realtors identify potential leads from a variety of sources, such as social media, landing pages, website visits, and online listings.

Property Management – AI tools for real estate can help streamline property management in various ways. For instance, it enables businesses to track rental and property listings, tenant applications, lease agreements, maintenance requests, and other essential information.

Fraud and Compliance Detection – Computer vision, AI and ML in real estate can seamlessly detect listing manipulation and even help flag potential compliance issues against the Fair Housing Act, enabling realtors to ensure accurate and compliant listings.

Property Search – Many house searching applications provide advanced search filters, enabling investors to choose a property for purchase by setting their preferences for price, design, square footage, locations, etc. However, finding suitable properties can still be challenging due to the various irrelevant filters. Even if these apps do not prove true to investors' expectations, AI in commercial real estate can effectively address this issue.

Automating Due Diligence – "To err is human", and with all the manual processes of data entry in real estate, there is a lot of room for error. It is where AI comes as a rescue, comparing vast amounts of data and identifying inconsistencies or

inaccuracies between documents like lease agreements, loan applications, etc. During the loan approval process, it is crucial to help detect mismatched values listed on each document and reduce the risk of fraud in the loan sanction.

Property Analysis – Conducting the property analysis and future validation is intimidating, as calculating the right price depends on several factors. These factors include but are not limited to crime rates, transportation means, sound disturbance, schools, hospitals, light sources, purchasing trends, future development in the area, and so on. AI applications in real estate can help businesses provide correct information about a home.

Customer Support – The limitless capabilities of AI in customer support are hidden from none; it has already revolutionised businesses across industries. Seeing the growing potential of AI in customer service, real estate companies are now capitalising on AI-powered solutions.

Intelligent Data Processing – AI can easily extract relevant information from different documents like appraisals, lease agreements, and loan papers and can complete the task in minutes, which would otherwise take days when done manually (Appinventiv, 2024).

Heating, ventilation and air conditioning (HVAC) systems – essential in ensuring occupant comfort- are among the largest energy consumers in buildings. (Vakiloroaya, 2014). HVAC systems control indoor climate by regulating temperature, humidity, and air quality through various components like boilers, chillers, and air-handling units (Sinopoli, 2010). They consume significant energy, accounting for about 50 % of the total electrical energy in commercial buildings, but energy-efficient designs can reduce this considerably (Krarti, 2008). Modern HVAC systems employ intelligent control strategies to enhance comfort and energy savings by adapting to human comfort levels (Mirinejad et al., 2008).

3 THE ROLE OF AI AND ML IN TRANSFORMING THE REAL ESTATE SECTOR

AI and Machine Learning (ML) technologies have introduced several changes to how businesses function across industries. One such transformation can be seen in the real estate market, where AI and ML have become vital components of the industry's success. The role of AI in the real estate sector is graphically shown in Figure 3.



Figure 3 – Role of AI in the real estate sector (Solguruz, 2024)

Automating Data Analysis – Real estate professionals use artificial intelligence (AI) to sift through massive amounts of unstructured and structured data gathered from various sources, including construction licenses, zoning laws, property surveys, and titles. Data scientists use sophisticated statistical models and machine learning algorithms to sift through these information repositories in search of actionable insights that may aid real estate professionals in making more educated decisions throughout the buying, selling, renting, and building processes.

Improved Decision-Making – Access to vast amounts of accurate and relevant data allows managers and investors to make informed decisions about buying, selling, renting, or developing properties.

Enhanced Marketing Strategies – Real estate developers and agents can employ AI and ML technologies to create highly effective digital marketing campaigns tailored toward specific demographics likely to be interested in their services. Targeted ad placements on social media platforms like Facebook or LinkedIn reach desired audiences more accurately than traditional broadsheet newspaper classified sections ever managed.

Efficient Resource Management – Artificial Intelligence (AI) can greatly enhance resource allocation strategies during construction projects. By analysing big data sets that track progress against predetermined milestones, companies can implement measures designed to ensure projects' timely completion while avoiding unnecessary expenses or material waste.

Optimisation of Processes – Integrating AI within the real estate industry allows organisations to optimise various aspects of their business. By implementing automated workflows, firms can effectively monitor and manage progress to ensure compliance with regulations.

Changing Customer Expectations – With AI integration, user experiences significantly improve as advanced machine learning algorithms provide personalised recommendations customised to meet specific preferences. These intelligent suggestions help simplify searches and narrow down options based on unique criteria, enabling faster discovery of suitable properties or investment opportunities.

Transforming Design Standards – The real estate industry continues to experience rapid changes as new construction techniques gain popularity. One such technique involves integrating the Internet of Things (IoT) into buildings'

core framework using intelligent sensor systems, solar panel or wind turbine installations, drone workforce utilisation, 3D printer implementation, and augmented reality visualisations.

Transforming Customer Feedback System & Content – One area that has seen significant advances is using artificial intelligence (AI) in various forms, such as chatbots like ChatGPT from OpenAI, generative AI models like Stable Diffusion from Google Brain, and others. Chatbot platforms like ChatGPT in the Real Estate domain allow agents to automate responses to common questions and concerns from potential buyers and sellers.

In summary, deploying these technologies in your agency's workflow will not only enhance efficiency. Still, it will also enable your team members to do what they love most - work closely with people (Solguruz, 2024).

4 THE ROLE OF AI AND ML IN THE FIELD OF BUILDING SERVICES

Heating, ventilation and air conditioning systems, or HVAC systems, are an integral part of a building and create an interior environment suitable for human habitation. Technologies are also an inseparable part of people today, and they are revolutionising the HVAC system industry. By using AI algorithms and machine learning, HVAC systems are smarter, more efficient and able to optimise energy consumption more effectively. This makes it possible to achieve even higher comfort in the interior, improve energy efficiency and reduce energy consumption costs. Artificial intelligence involves the development of intelligent algorithms that enable machines to learn from data, make decisions and perform tasks without explicit programming. In HVAC systems, AI algorithms analyse data from various sensors and inputs and aim to optimise system operation, air flow, heat regulation and energy consumption. HVAC systems that are controlled by AI have the ability to learn the demands and preferences of occupants and continuously adjust settings. AI in HVAC systems also provides a personalised approach that radically increases occupant comfort and satisfaction. The constant process of improving AI and technology predicts transformative trends like:

- AI algorithms will become even more sophisticated when analysing sensor data, equipment performance, weather forecasts, or occupancy patterns, allowing HVAC systems to predict and optimise energy consumption, anticipate maintenance, and adapt to changing conditions in real-time.
- Future AI-controlled HVAC systems will have enhanced capabilities to optimise energy efficiency further. The AI algorithms will use advanced machine-learning techniques that will be adapted to the ever-changing dynamics of the building.
- AI-controlled HVAC systems will interact with other smart building technologies that are already in use today, such as lighting control, building

occupancy and building management systems. This integration will allow access to building automation where AI algorithms optimise energy consumption in multiple systems, thereby ensuring overall operational efficiency.

Currently, buildings use systems that are operated on the basis of predetermined set values and schedules of operations or on the basis of an individual's request. This leads to wasted energy. Control of these systems effectively can be achieved through the application of AI (Ghahramani, Galicia, Lehler et al., 2020).

From 1997 to 2022, a total of 1785 relevant works on artificial intelligence in heating, ventilation and air conditioning were processed. It is clear that this topic is well-researched and described by quality professional papers. Artificial intelligence in HVAC systems plays a role, especially in the field of energy saving. Further research has shown that since 2000, 31,221 patents have been issued that relate to the energy saving of AI-based HVAC systems. Many well-known companies report that using AI in HVAC systems has quality effects on energy saving (Dasheng, Shang-Tse, 2023). Various companies have applied AI mainly in two parts of HVAC systems - coolers and air conditioning. AI uses various parameters, including temperature, pressure, number of people entering and leaving, and thermal load in the interior. The results of analyses of energy savings thanks to AI vary between 20% and 70 % between different companies. Uncertain results in energy saving can hinder the application of AI.

Studies by global experts have explored the use of AI design in energy-efficient HVAC systems. Also, the energy efficiency of these systems was quantitatively analysed, especially the achievable energy-saving ratio with the use of AI. Data from numerous case studies were also collected to define the necessary hardware modifications to HVAC systems. No case study has yet discussed whether the HVAC system hardware needs to be updated. Therefore, there are discussions about how HVAC hardware works with AI. Based on this, research gaps need to be addressed (Dasheng, Shang-Tse, 2023).

Studies of AI combined with HVAC systems explore many areas. It is worth mentioning the study by Machlev et al., who reviewed the development of explainable AI techniques and energy systems (Machlev et al., 2022). Explainable AI is an interesting development that improves the explainability of ML (Machine learning) models in order to better understand their output. However, this review pointed out that most ML models that use explainable AI are traditional ML algorithms, and DL (Deep Learning) models are rarely used with this technique. Another survey by experts Chen et al. was the latest overview of interpretable M" for building energy management (Chen, Xiao, 2023).

Advantages provided by HVAC systems controlled by AI are:

- Cost and energy savings – The performance of proper AI HVAC systems is energy efficient, saving the building's operating costs. AI-controlled HVAC systems can adapt their operation to changes in the environment and

optimise energy consumption by detecting and responding to these changes. Long system life and predictive maintenance help increase energy efficiency and reduce operating costs.

- Comfort and improvement of air quality – The AI system can determine the parts of the building that need heating, cooling, temperature regulation, or removal of humidity and impurities in the air. In doing so, they radically improve air quality by analysing data and finding patterns.
- System lifetime and predictive maintenance – The AI system enables rapid identification and repair of faults. This contributes to the longer life of HVAC systems and lower repair costs. An AI system is capable of learning from its own previous mistakes.
- The possibility of AI integration with smart home systems – Smart homes combine many devices and technologies to provide owners with convenient and efficient home equipment. Integrating AI-controlled HVAC systems with smart home systems facilitates interaction between these systems.
- Remote control and monitoring capability – This feature offers ease and flexibility by allowing owners to remotely control and adjust HVAC system settings.

The combination of HVAC systems controlled by artificial intelligence currently provides many advantages. With evolving technology, we can expect greater adoption in the real estate industry. Smart yet efficient homes can be a big selling factor. In the future, it is estimated that AI-controlled HVAC systems will be a common part of buildings as energy efficiency becomes a bigger concern. This trend towards energy-efficient housing can benefit the environment by reducing carbon emissions and promoting sustainability.

5 DISCUSSION

Artificial intelligence (AI) serves as a key point in the transformative process as advanced information technologies and real estate converge. The influence of high-tech IT on the emotional experience is unmistakable, beginning with marketing and ending with the experience of living in a house. Smart homes that use artificial intelligence create high-tech points of contact between people and their living area, thereby strengthening their sensory perception of their surroundings. The influence of AI is constantly increasing in the construction and real estate sector as traditional task execution is enabled through subconscious interactions such as voice commands, facial expressions and movement tracking. Interactive programme flows, and mobile applications improve this additional bond. AI is multidimensionally applicable and is fundamentally changing standardised practices when it comes to innovation, as it is an enabler for fundamental changes in customer expectations for personalised communications. The change in standardised design understanding and service in building

management can be seen in the development of HVAC systems, as the AI procedures intuitively adapt to the needs of residents, expanding comfort and sustainability. AI enables improved resource management and enables predictive maintenance through streamlined processes to generate cost savings. However, the active groups must protect privacy and data security in an increasingly digitalised system so that AI solutions enable new growth opportunities and competitive advantages in the digital age.

6 CONCLUSION

AI has redefined the real estate industry in the areas of business productivity, customer experience and construction processes. As the study proves, AI and other innovative technologies such as drones, IoT and VR will reshape the fundamentals of real estate operations. Improving HVAC systems in terms of energy consumption and customer comfort and reimagining customer relationship management and marketing strategies will put AI at the heart of every competitive and growing real estate business model. Furthermore, AI adoption based on a precisely formulated strategic approach becomes crucial for the competitiveness and growth of the real estate market.

Therefore, the in-depth literature review and case studies have promising opportunities to illustrate the extent to which AI is beneficial in the comprehensive automation of data processing, better decision making and facilitating property management through predictive maintenance. In addition, issues of privacy, security, and hardware requirements could be addressed to leverage AI applications in the real estate sector.

In short, the paper explains the transformative impact that AI will have on the real estate sector and, therefore, provides insights into how such technologies can be leveraged in today's times to lead to world-class operational excellence and desirable customer satisfaction. The basis for the paper's scientific contribution is based on the criticism and scientific evidence, which will lead to a basis for broader research and use of AI in the real estate industry in the future.

REFERENCES

- Srivastava, S., 2024. Benefits of AI in real estate: transforming property transactions and customer insights. *Appinventiv*, blog 11 April 2024. Available at: <https://appinventiv.com/blog/ai-in-real-estate/> [Accessed: 28 April 2024].
- Arumugam, T., Arun, N., Anitha, R., Swerna, P.L., 2024. Advancing and Methodising Artificial Intelligence (AI) and Socially Responsible Efforts in Real Estate Marketing. *Data-Driven Intelligent Business Sustainability*. IGI Global, pp. 48-59.
- Azmi, A., Ibrahim, R., Ghafar, M.A., Rashidi, A., 2022. Smarter real estate marketing using virtual reality to influence potential homebuyers' emotions and

purchase intention, *Smart and Sustainable Built Environment*, 11(4), pp. 870-890. <https://doi.org/10.1108/SASBE-03-2021-0056>.

Dasheng, L. and Shang-Tse, L., 2023. Artificial intelligence enabled energy-efficient heating, ventilation and air conditioning system: Design, analysis and necessary hardware upgrades, *Applied Thermal Engineering Journal*, 235, 121253. <https://doi.org/10.1016/j.applthermaleng.2023.121253>.

Ghahramani, A., Galicia, P. and Lehler, D., et al., 2020. Artificial Intelligence for Efficient Thermal Comfort Systems: Requirements, Current Applications and Future Directions, *Frontiers in Built Environment*, 6. <https://doi.org/10.3389/fbuil.2020.00049>.

Chen, Z. and Xiao, F., 2023. Interpretable machine learning for building energy management: A state-of-the-art review, *Advances in Applied Energy*, 9. <https://doi.org/10.1016/j.adapen.2023.100123>.

IT-techBlog, 2006. Unternehmen in der Internetökonomie, Ziele des IKT-Einsatzes. Available at: <https://www.it-techblog.de/know-how-intel-centrinomobiltechnologie-im-detail/10/2006/> [Accessed: 26 April 2024].

Krarti, M., 2008. Energy Efficient Systems and Strategies for Heating, Ventilating, and Air Conditioning (HVAC) of Buildings, *Journal of Green Building*, 3(1), pp. 44-55. <https://doi.org/10.3992/jgb.3.1.44>.

Machlev, R., et al., 2022. Explainable Artificial Intelligence techniques for energy and power systems: Review, challenges and opportunities, *Energy & AI*, 9. <https://doi.org/10.1016/j.egyai.2022.100169>.

Mirinejad, H., Sadati, S., Ghasemian, M. and Torab, H., 2008. Control Techniques in Heating, Ventilating, and Air Conditioning (HVAC) Systems, *Journal of Computer Science*, 4, pp. 777-783. <https://doi.org/10.3844/jcssp.2008.777.783>.

Pleyers, G. and Poncin, I., 2020. Non-immersive virtual reality technologies in real estate: How customer experience drives attitudes toward properties and the service provider, *Journal of Retailing and Consumer Services*, 57. <https://doi.org/10.1016/j.jretconser.2020.102175>.

Rossini, P., 2000. Using expert systems and artificial intelligence for real estate forecasting, in *Proceedings of the Sixth Annual Pacific-Rim Real Estate Society Conference*, Sydney, Australia, pp. 24-27. Available at: https://www.prrs.org/uploads/481/1120/Rossini_Using_Expert_Systems_and_Artificial_Intelligence_for_RE_Forecasting.pdf [Accessed: 29 May 2024].

Sinopoli, J., 2010. Heating, Ventilating, and Air Conditioning Systems, *Smart Building Systems for Architects, Owners, and Builders*. pp. 31-46. <https://doi.org/10.1016/B978-1-85617-653-8.00003-X>.

Solguruz, D.L., 2024. Benefits of AI in real estate: transforming property transactions and customer insights. Available at: <https://solguruz.com/blog/role-of-ai-and-ml-in-transforming-the-real-estate-sector/> [Accessed: 25 April 2024].

Statista GmbH, 2019. Number of desktop PCs and notebooks sold on the consumer market in Germany from 2005 to 2018 (in 1,000 devices). Available at: <https://www.statista.com/statistics/462726/pcs-and-notebooks-sales-volume-germany/> [Accessed: 20 April 2024].

Statista GmbH, 2019a. Number of tablet PCs sold to private consumers in Germany from 2010 to 2018 (in millions). Available at: <https://www.statista.com/statistics/460123/tablets-consumer-market-sales-volume-germany/> [Accessed: 29 March 2024].

Statista GmbH, 2019b. Technik-Shopping in Deutschland. Available at: <https://de.statista.com/infografik/16197/absatz-von-ausgewaehlten-elektronischen-geraeten-in-deutschland/> [Accessed: 09 Mai 2024].

Taffese, W.Z., 2006. A survey on application of artificial intelligence in real estate industry. Proceedings of the Third International Conference on Artificial Intelligence in Engineering & Technology. November 22-24, 2006, Kota Kinabalu, Sabah, Malaysia. Available at: https://www.researchgate.net/publication/236866441_A_Survey_on_Application_of_Artificial_Intelligence_in_Real_Estate_Industry [Accessed: 29 March 2024].

Thaduri, U.R., 2021. Virtual Reality & Artificial Intelligence in Real Estate Business: A Tool for Effective Marketing Campaigns, *Asian Journal of Applied Science and Engineering*, 10(1), pp. 56-65.

Ullah, F., Sepasgozar, S. and Wang, C. 2018. A systematic review of smart real estate technology: Drivers of, and barriers to, the use of digital disruptive technologies and online platforms, *Sustainability*, 10(9), p. 3142. <https://doi.org/10.3390/su10093142>.

Vakiloroaya, V., Samali, B., Fakhar, A., Pishghadam, K., 2014. A review of different strategies for HVAC energy saving, *Energy Conversion and Management*, 77, pp. 738-754. <https://doi.org/10.1016/j.enconman.2013.10.023>.

Verma, S., Sharma, R., Deb, S., Maitra, D., 2021. Artificial intelligence in marketing: Systematic review and future research direction, *International Journal of Information Management Data Insights*, 1(1), p. 100002. <https://doi.org/10.1016/j.jjime.2020.100002>.

Viriato, J.C., 2019. AI and machine learning in real estate investment, *The Journal of Portfolio Management*, 45(7), pp. 43-54. <https://doi.org/10.3905/jpm.2019.45.7.043>.

Vlačić, B., Corbo, L., Costa e Silva, S., Dabić, M. 2021. The evolving role of artificial intelligence in marketing: A review and research agenda, *Journal of Business Research*, 128, pp. 187-203. <https://doi.org/10.1016/j.jbusres.2021.01.055>.

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CONFLICTS OF INTEREST

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