Al-Qadisiyah JournalFor Engineering Sciences 18 (2025) 092 – 098

Contents lists available at: http://qu.edu.iq

Al-Qadisiyah Journal for Engineering Sciences

Journal homepage: https://qjes.qu.edu.iq

Research Paper

Forecasting technologies impacting real estate business during the transition to 2030s

Kongkoon Tochaiwat [1,2]✉, ***Anuwat Budda*** [1,2], ***and Patcharida Seniwong*** [2]

[1] *Faculty of Architecture and Planning, Thammasat University, Pathum Thani, Thailand.*
[2] *Thammasat University Research Unit in Project Development and Innovation in Real Estate Business, Thammasat University, Pathum Thani, Thailand.*

ARTICLE INFO

Article history:
Received 15 September 2024
Received in revised form 10 January 2025
Accepted 12 March 2025

keyword:
Real estate sales
Real estate technology
Trend forecasting
Technology management
Modified delphi method

ABSTRACT

Currently, numerous technologies play a significant role in the real estate business, particularly in meeting the needs of prospective buyers and residents of housing projects. However, the competition and risks in the industry compel real estate developers to carefully compare the advantages and disadvantages that may arise from the adoption of technology. This research aims to examine the trends in technologies implemented in housing development projects during the transition from the 2020s to the 2030s. The survey involved interviews with five real estate experts who possess knowledge and experience in (1) design, (2) construction, (3) innovation management, (4) location selection, and (5) real estate sales and marketing. The interview results were analyzed using the Content Analysis Technique. The findings indicate a high likelihood that technologies facilitating home convenience and safety, air circulation technologies, energy-saving technologies, wellness support technologies, environmental pollution detection technologies in communal areas, prefabricated house technologies, cost-reducing or recycled material usage technologies, smart home technologies, renewable energy technologies, home network control technologies and internet network technologies, and advertising and public relations technologies to increase project awareness among potential homebuyers will become prominent. In addition, the development of post-occupancy resident care applications is anticipated. These findings can be used by businesses in related industries to develop products and services that better meet the needs of homebuyers and enhance their quality of life.

1. Introduction

Currently, numerous technologies are playing crucial roles in real estate operations, aimed at enhancing convenience for prospective homebuyers and residents of self-managed community projects. These innovations are designed to address challenges and support usability, while fostering satisfaction with technology and innovation. These changes signify a transformation in human lifestyles, not only improving the quality of life but also facilitating human-environment co-existence [1]. However, the competitive technology market demands high investment and involves risks in terms of developing new technologies [2]. In addition, the high competition and risks of Thailand's real estate industry have been significant, compounded by the current situation with various factors contributing to the reduction of purchasing power among residents [3]. Therefore, it is imperative to carefully compare the advantages and disadvantages that may arise from the adoption of technologies to provide valuable information for real estate developers and stakeholders, enabling them to evaluate and select appropriate technologies for their operations and project development to achieve high efficiency of resource utilization. As such, this research aimed to investigate which technologies are suitable for the development of residential projects in Bangkok from 2031- to 2039 [4], focusing on five important processes in the real estate value chain [5–7]. The timeframe is in accordance with the 3-to-10- year duration for technological forecasting suggested by Quinn [8]. From the perspective of the real estate business, Bangkok, the capital city of Thailand, serves as a hub for population and employment. Statistical data show that Bangkok accounts for up to 24.21% of the country's vacant job positions [9]. This economic concentration makes centrally located land relatively more expensive than the outskirts, which is intensified by dwindling land availability each year. Consequently, property developers are compelled to raise residential prices significantly, despite stagnant household incomes [10]. Hence, this research can potentially leverage technology to develop real estate that adds value by meeting homebuyer's demands and fostering better living conditions. With knowledge of these technologies, real estate developers can use technology as a selling point beyond traditional factors such as location or price.

2. Literature review

According to the value chain concept [5], technologies can support several real estate development processes, including key primary processes such as location selection, design, construction, marketing and selling and secondary activity innovation management [7]. This concept aligns with the key real estate activities concerning technologies mentioned by Maududy and Gamal [6]. Based on studies and gathering of ideas, theories, and relevant research documents concerning technologies applicable to future residential community projects over the next decade, the following framework and guidelines were proposed for the study and conceptual framework development.

2.1 Technological trends in design

Currently, technology is being applied in various forms within the real estate sector, particularly in subdivision projects. Design plays a crucial role in spatial functionality and project esthetics.

*Corresponding Author.
E-mail address: kongkoon@tu.ac.th ; Tel: (+6699-289-3328) (Kongkoon Tochaiwat)

https://doi.org/10.30772/qjes.2025.155895.1450
2411-7773

Nomenclature

Smart home technology	Smart home technology that emphasizes ease of use, enhanced comfort, and improved security for modern living.
Inclusive space adaptation	Adjusting environments to meet various needs, ensuring accessibility, and fostering inclusivity for diverse users.
Special purpose materials	Employing materials designed to lower noise levels, improve energy efficiency, and enhance airflow within a space.
Centralized pollution detection	Integrating technology to monitor and detect environmental pollution in key urban areas for better management and control.
Connectivity via internet systems	Communication between residents and project managers via internet-based systems for seamless interaction and coordination.
Prefabricated home technology	Focusing on advanced prefabricated housing technology to improve construction efficiency, sustainability, and affordability.
Use of cost-effective materials	Using affordable materials to optimize costs while maintaining quality and efficiency in construction and decoration.
Integration of ICT like BIM	Utilizing information communication technologies like BIM and VR to enhance project visualization and management.
Online communication platform	Creating digital communication platforms to enhance connectivity, interaction, and information exchange efficiently.
Geolocation identification	Technology for determining and tracking geographic locations with accuracy and efficiency.
Advertising and distribution	Digital platforms for advertising and distributing residences or services to reach a wider customers efficiently.
After – sales service	Providing customer support and after-sales service through a mobile application for convenience and efficiency.

The literature review provides significant insights into the technological applications of design, as follows: From the literature review, it was found that various design technologies should be applied from the project's inception in real estate development, because of their importance in planning and optimizing operational processes [11, 12]. Technology in home design has been developed to enhance interior space versatility and resident satisfaction, particularly in terms of convenience and security [13]. This encompasses smart home technology devices, which significantly influence home buying decisions, as evidenced by the studies of Zielonka et al. [14] and Tiwari et al. [15], These findings, align with energy-efficient design practices to reduce long-term household costs [16]. Literature also supported the necessity of technology use in elder-friendly residential design, advocating for simple yet diverse usability [17]. Future-oriented designs consider the aging population and incorporate household technology advancements for convenience and safety [18]. Furthermore, it has been found that technology can also be used to determine site locations, road lengths, and development directions for projects, ensuring that the area achieves maximum efficiency [19]. These findings underscore the critical role of technology integration in home design processes. In summary, trends in design technology focus on enhancing the quality of life, whether through air circulation, energy efficiency, soundproofing materials, or the principles of universal design. Figure 1 shows examples of universal design elements that enhance convenience and safety elderly and disabled people.

2.2 Technological trends in construction

In current residential community development projects, technology has been applied to construction operations to reduce costs, enhance quality, or expedite project completion. The literature review identified technologies commonly used by developers and project stakeholders, including the following: According to Chen et al. [20] and Madireddy et al. [21], the use of prefabricated home construction technology helps reduce the complexity of house construction and improves construction efficiency. This aligns with the findings of Chippagiri et al. [2] and Sua-iam and Makul [22], that stated prefabricated home technology can save time, reduce costs, be environmentally friendly, and minimize construction waste, thus promoting sustainable business practices. This trend was also supported by Kaja and Jauswal [23], who highlighted prefabricated homes as a high-quality technology that fosters long-term sustainability and cost savings. Furthermore, another significant technology that represents an important trend for the future is the use of low-environmental impact construction materials, such as hydraulic cement, Electric Arc Furnace steel bars, lightweight bricks, green glass, water-saving sanitary structures, and LED lighting, as well as the use of recyclable materials [24]. These construction technologies contribute to the sustainable construction, which was discussed by Wong and Loo [25] and Masood and Roy [26], emphasizing sustainability as crucial for the environment and buildings. While the application of prefabricated home technology offers benefits in reducing carbon dioxide gas emission and construction waste, it may pose limitations for houses requiring specific esthetic appeal or design flexibility, which developers should consider [27, 28].

2.3 Technological trends in innovation management

For the application of innovation in residential community development projects, a wide variety of innovations are currently available that enhance convenience within homes [1, 29]. These innovations are considered as trends in future technology, supported by detailed literature reviews on various aspects related to innovation, including the following From the literature review, it was found that the innovations normally applied to real estate projects include solar energy technology, the installation of efficient air circulation systems, and smart homes [30]. This aligns with the research by Zhang et al. [1], which indicated that residents are willing to pay extra for innovations that help save water and electricity, thereby reducing long-term household expenses. This is consistent with the findings of Marikyan et al. [30], who highlighted that integrating innovative technologies within homes significantly enhances resident satisfaction in utilizing various spaces within the household, enhancing safety and convenience for family members. According to Albany et al. [31], smart home technology interconnected via the internet across all home systems improves the residential living experience [32], providing greater comfort and enhancing the future quality of life for residents. Additionally, it has been found that technology can be utilized in the form of application development within projects to connect the networks of resident communities in a location, thereby facilitating the creation of a shared awareness [33]. Currently, Building Information Modeling (BIM) and Virtual Reality (VR) technologies are being adopted. Several researchers have emphasized the integration of these technologies into the design and development process, which helps enhance data organization and design efficiency at various stages [34]. These are the crucial aspects of innovation trends identified in the literature, that stakeholders involved in housing projects should carefully consider and integrate into their operations.

2.4 Technological trends in location selection

Currently, location and area are crucial factors influencing the sales value of residential housing projects [35]. They serve as performance indicators that affect success. Literature review revealed research discussing trends in single-family home technology focused on location. The literature review, it was an evident that having a poor location adversely affects the market value of homes [35]. Research by Grønhaug K. et al. [36] indicated that residents often choose their residences based on proximity to various lifestyle-related places, including commuting distance and workplace locations. This aligns with the findings of Ismail and Shaari [37], who emphasized the importance of technology or factors that enhance accessibility and convenience within residential projects, influencing resident satisfaction with various living spaces. Markus [38] discussed the trend of internet-related technology as a crucial factor enabling communication across different locations and teamwork, even when residents are not physically close to their workplaces. Furthermore, Zelenkov and Lashkevich [39] supported internet-based communication, fostering human communication development, which is beneficial for remote work and easier access to organizational work systems. These factors increase flexibility in choosing residential project locations. Barrero et al. [40] also mentioned that remote working systems promote the ability for people to work from home or access organizational work information more conveniently, affecting residential location choices similarly. Zhang et al. [41] found that technology supporting travel systems and convenient commuting areas are crucial for worker's communities. These findings are consistent with Magara and Zhou's [42] research, indicating that in the future, internet-connected technology will be another important factor in facilitating convenience for residents in residential housing, leading toward sustainable urban development [43]. Furthermore, other geographic technologies have been adopted to survey population density and areas, as these are crucial for constructing infrastructure and communities [44]. These indices serve as measures for assessing the sustainability of an area and the relationship between residents in projects and the urban community is dynamic in the future [45, 46]. Finally, the integration of Geographic Information System (GIS) technology into internet platforms enhances convenience and efficiency in accessing land or residential information for real estate developers and homebuyers, respectively [47]. Currently, GIS has been found to be an effective remote sensing tool that can effectively access and assess the conditions of the environment in the area [48]. Figure 2 and Fig. 3 show examples of the GIS platform where developers can find important data and check the data of the land they are interested (Figure 2) and the platform where homebuyers can find and check the data of their properties (Figure 3).

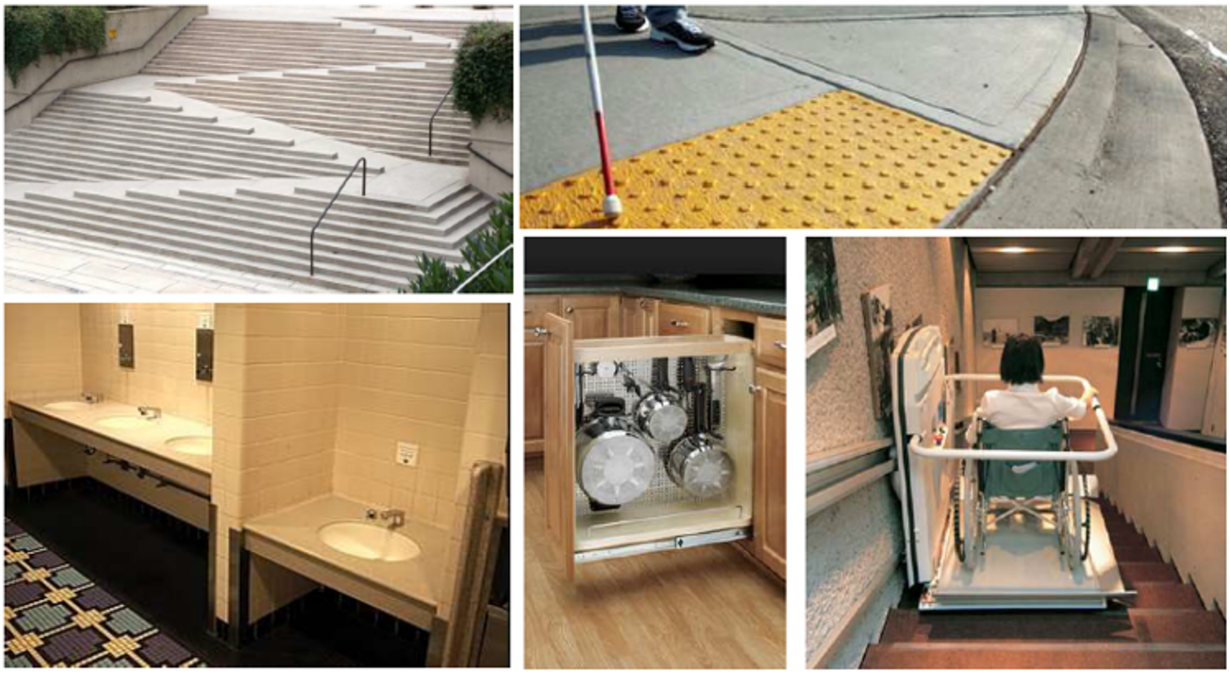

Figure 1. Universal Design Elements. (Source: thinkinclusive.us and blog.oregonlive.com)

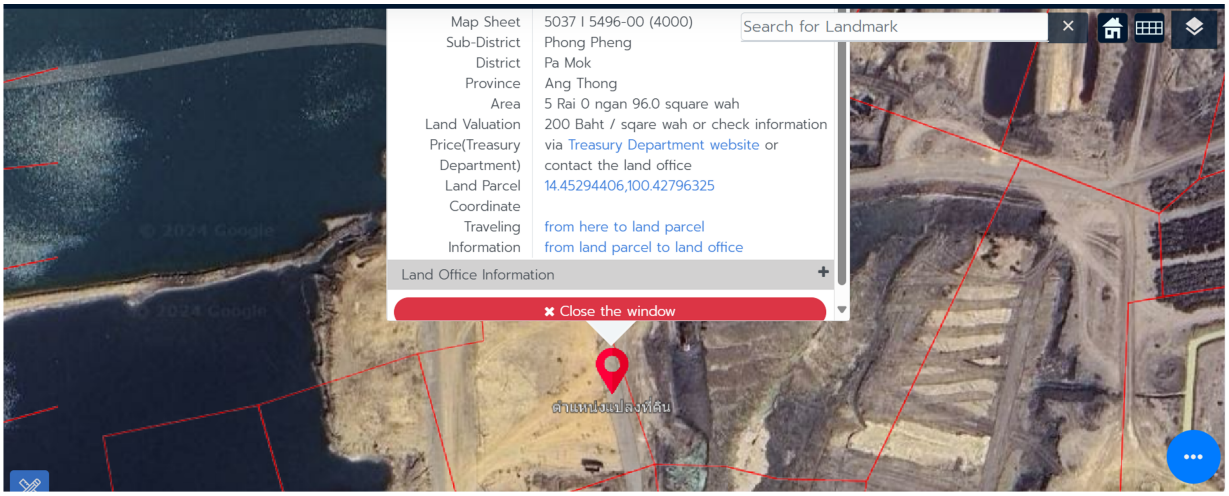

Figure 2. Example GIS for a developer. (Source: landsmaps.dol.go.th)

2.5 Technological trends in sales and marketing

Currently, numerous marketing technologies are extensively used in businesses to achieve success, serving as mediums to reach consumers and communicate product details effectively. This includes the single-family housing development sector, in which developers and project managers opt to employ technology for customer communication. The literature review revealed the following details: Ibrahim et al. [49] highlighted that using technology for data collection and processing significantly influences the understanding of customer needs, thereby greatly enhancing the marketing development of housing projects. This helps streamline the project sales presentations. Similarly, Zulkifli and Ismail [50] emphasized that motivation is crucial in home-purchasing decisions. This finding aligns with Cheam et al. [51], who found that location factors and marketing communications are pivotal in motivating homebuyers. These findings corroborate those of Samudro et al. [52], who noted that leveraging technology to boost sales effectively increases home purchases. Furthermore, Rahmawati and Ismartaya [53] stated that designing homes in projects and using technology as communication tools facilitate easier decision-making for buyers. Additionally, Sudrajad and Sutanto [54] suggested that marketing technology is a key strategy for successful projects. These factors underscore the influence of marketing technology trends expected to increase in the future [55], which is in line with the findings of Lovicu et al. [56], who discussed how financial policy as an advertising medium can support decision-making among homebuyers. Furthermore, Ashour and Sultan [57] found that technology can play a significant role in prioritizing issues and allocating financial resources. In addition to marketing and sales processes, technology is also applied in after-sales services. Some real estate developers in Thailand have developed applications that allow homebuyers to make inquiries, request repairs, or access various additional services related to living within the project, such as reserving times for using communal facilities, paying common fees, or hiring gardeners and housekeepers [58].

3. Methodology

This research applied a qualitative approach to study the technology trends used in the real estate development business, specifically in housing allocation projects, during the transition into the new decade (2031-2039). The study involved interviews with five real estate experts who have diverse experiences in five areas: (1) design, (2) construction, (3) innovation management, (4) location selection, and (5) sales and marketing. The selection criteria for interviewees included a minimum of 10 years of experience in relevant fields and qualifications such as: (1) working in organizations related to the interview topics, (2) having received awards or published works internationally recognized in relevant fields, or (3) holding positions such as university professors,

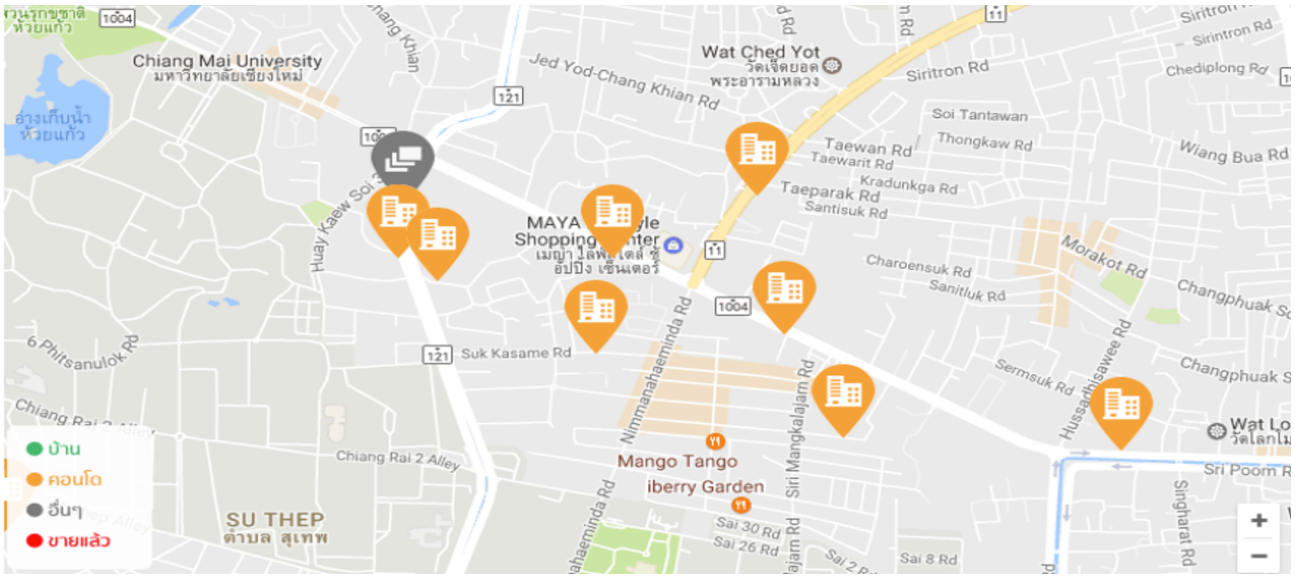

Figure 3. An example of a GIS for homebuyers. (Source: baania.com)

general manager, or Managing Directors. Figure 4 presents a list of interview questions. Subsequently, Content Analysis was conducted to derive conclusions and recommendations regarding future technology trends in these five areas.

4. Results and discussion

From the interviews with the five experts regarding the different technology trends, it was found that the detailed findings from the collected interviews can be presented. The characteristics of these experts are summarized in Table 1. As listed inTable 1, the experts possess diverse qualifications and considerable work experience. They are reputable and recognized within their respective industries, making them suitable informants for research findings. The list of technologies mentioned by the experts is shown in nomenclature list, with the details of all technologies as follows.

4.1 Design technology

The experts noted that future family trends are likely to involve elderly members and smaller families of up to four individuals. Regarding technological trends for development projects, the authors recommend the following:

- Technology related to convenience and safety within homes, such as smart home technology capable of detecting residents' movements to prevent hazards.
- Materials should consider soundproofing to enhance privacy and accommodate versatile use of spaces for diverse future activities.
- Use of air-circulation systems and long-term energy-saving technologies.
- Integration of technologies that centrally connect caregivers to ensure home security within projects. In addition, project common areas should focus on health-maintaining technologies or support exercises. Moreover, environmental monitoring technology should be employed to help maintain air cleanliness and internal environmental care within the project.

4.2 Construction technology

The construction trend identified from the research was the control of costs, quality, and construction timelines. The experts also suggested that prefabricated housing technology has promise in addressing these issues. However, further research and development are needed to advance this technology. Prefabricated homes can be more accurately calculated construction timelines, and manufacturing them in factories reduces the risk of labor-related issues during construction. This approach positively impacts quality control and construction costs. Regarding material selection, the experts suggest exploring new materials or recyclable materials, which are environmentally friendly. If the production costs of a certain material type are lower, there is a tendency for it to be chosen as an option in construction projects.

4.3 Innovation management technology

In the context of innovation management, the findings indicate a diverse range of technologies and development approaches across different organizations. Key trends in project development include design, residential living, and renewable energy, which serve as factors determining suitable technologies for further enhancement. Additionally, the experts asserted that the ongoing and assured development of smart home technology is pivotal. This technology not only supports residential living, but also facilitates communication between homeowners and project managers. Moreover, it helps filter external and internal personnel to enhance residential security. In terms of architectural and building design, the experts emphasized the use of BIM for its convenience in project presentation to stakeholders and clients. When integrated with VR technology, BIM further enhances the convenience of project design, construction, and management.

Part A: Screening Questions:

1) What is your occupation and current position?
2) Do you have more than 10 years of work experience?

Part B: Technology trends:

3) In your opinion, which technologies will significantly impact real estate business in the areas of (design / construction / innovation management / location selection / marketing) during the early part of the next decade (2030–2039)?
4) How do these technologies positively and negatively affect stakeholders in the real estate business?
5) Do you have any additional suggestions regarding the adoption of these technologies?

Figure 4. Interview questions.

4.4 Location technology

The experts believe that in terms of selecting land locations in the future, projects will increasingly be situated in suburban areas, particularly in the eastern and western outskirts of Bangkok. This trend is driven by advancements in online business, which reduce the need for residents to commute. Additionally, technologies for remote communication will facilitate convenience, whereas location-based technologies will see greater utilization due to advancements in geographic information technology (GIS).

4.5 Sales and marketing technology

As for the technology in sales and marketing, the results highlighted technologies of interest to experts, focusing on customer service enhancement, simplifying management processes from customer access through advertising, facilitating visits and purchase decisions in property projects, and after-sales services. The experts foresaw that future residents would embrace diverse lifestyles, seek novel experiences, and prompt projects to compete in customer

Table 1. Details of the experts.

Experts	Occupation	Position	More than 10 years of work experience.
Design experts	Designer	Company partners	YES
Construction experts	Contractor	Company owner	YES
Technology experts	Real estate developers	Company partners	YES
Location experts	University professor	Conduct research and teach in urban planning.	YES
Marketing experts	Real estate developers	Company owner	YES

satisfaction. Future home purchases may emphasize smart home devices, with installation services minimizing inconveniences. Moreover, leveraging online influencers can attract customers who closely follow these personalities. Thus, selecting customer-accessible advertising media and influential online personalities will significantly impact future customer groups. In terms of after-sales service, using communication systems via applications to maintain or repair homeowners' houses will positively impact the organization's image and foster word-of-mouth among existing residents and potential homebuyers.

5. Conclusion and recommendations

Based on the research findings, it is evident that these can be further recommended to stakeholders across various parties, with detailed specifics as follows:

5.1 Conclusion

Based on the research findings, the technology trends likely to influence the real estate business entering the 2030s can be summarized as follows:

5.1.1 Design technology trends

- Smart home technology – The technology that focuses on convenience, comfort, and security
- Inclusive space adaptation - Adaptation of spaces for diversity
- Special purpose materials - Use of materials that reduce noise, save energy, and promote air circulation
- Centralized environmental pollution detection technology - Implementation of environmental pollution detection technology in central areas
- Resident-manager connectivity via internet systems - Connectivity between residents and project managers through internet systems.

5.1.2 Construction technology trends

- Prefabricated home technology - Emphasis on prefabricated home technology to increase competitiveness
- Use of cost-effective materials - Utilization of cost-effective materials in construction and decoraton.

5.1.3 Innovation technology trends

- Smart home technology
- Internet-based communication for managers and residents - online connectivity between project managers and residents for communication or facility management
- Integration of ICT like BIM and VR - Application of information communication technologies such as BIM and VR.

5.1.4 Location technology trends

- Online communication platform - Development of online communication systems
- Geolocation identification technology - Geographic location identification technology.

5.1.5 Marketing technology trends

- Digital advertising and distribution channels – Efficiently reaching customers by online advertising and distribution channels
- Application-based after-sales service – Providing convenient and effective after-sales service via the application.

These trends are anticipated to shape the future landscape of the real estate industry as it continues to progress into the 2030s. It is evident from the trends in technology that a significant emphasis is placed on convenience and cost reduction, particularly in terms of time, renewable energy, and assets. This aligns with the literature review conducted by Zielonka et al. [14], who suggested that smart home technology and various cost-saving technologies currently contribute to residents' convenience and are expected to increase in importance in the future. This should be taken into consideration by stakeholders involved in various project processes. This article suggested the technologies of five trends during the transition to the 2030s:design, construction, innovation management, location, marketing and sales. The research results are in accordance with the trends mentioned in several studies, such as the trend of interior space versatility [13], smart home technology [13, 14, 59], prefabricated houses [23], low-environmental impact construction materials [24], BIM and VR technologies [33], GIS technology [47, 48], and after-sales-service applications [58]. However, some trends seem to be specific to Thailand, due to its different business environment and processes, such as environmental pollution detection technology in central areas, cost-effective materials and online advertising and distribution channels. In summary, technologies can support the real estate business in several ways: enhanced convenience, cost reduction, time reduction, renewable energy utilization, and property management efficiency.

5.2 Recommendations to stakeholders

Based on the summarized findings, it is possible to formulate recommendations relevant to stakeholders from various departments as follows:

1. Entrepreneurs and project developers
   In applying these recommendations, we found prioritize technologies related to location identification and geospatial aspects should be prioritized. These metrics are directly linked to pinpointing project areas. Subsequently, various technologies should be considered in accordance with the sequence of project construction operations and business management among other stakeholders.

2. For designers, contractors, and innovators
   When applying research findings to design, construction operations, and innovation analysis, stakeholders should prioritize smart home technology as a crucial factor for enhancing resident convenience. Subsequently, consideration should be given to materials or technologies that contribute to energy efficiency throughout the construction process and in the integration with various household appliances, aiming to achieve sustainable living in the future.

3. For marketers
   To apply this method, marketers should emphasize using advertising media to reach residential decision-makers through influencers that are currently popular online. They should utilize various formats of online media that are trending and offer sales promotions related to financial incentives and additional gifts to customers.

4. Future researchers pursuing further studies.
   This research applied a qualitative approach. The number of informants was determined to five experts, which was sufficient according to Creswell (2014) [60]. However, interested researchers can perform similar research work using a quantitative approach, which collects and analyzes data from more respondents to acquire results from different perspectives, such as the efficiency levels of the technologies. Furthermore, when applying these research methods in the future, researchers can adapt them to different residential formats or apply them to larger interviewee groups to enhance diversity and generate new knowledge. This can serve as supportive evidence when compared with similar research endeavors.

Finally, this research may have limitations, such as focusing on single-family homes in a residential village project, and utilizing interviews with only five experts. Although the number of experts is acceptable [60], but it seems very small compared to the number of design firms, contractor companies, and academic institutes in Thailand. Therefore, these limitations can be considered when conducting similar research in the future.

Authors' contribution

All authors contributed to every stage of the preparation of this article.

Declaration of competing interest

The authors declare no conflicts of interest.

Funding source

This study didn't receive any specific funds.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgements

This research was supported by a grant from the Thammasat University Research Unit in Project Development and Innovation in Real Estate Business, Thammasat University. In addition, the authors would like to acknowledge the Faculty of Architecture and Planning, Thammasat University, for the additional supports.

REFERENCES

[1] K. Zhang, "An affordable nearly-zero-energy townhouse prototype for china's future low-carbon housing," *Cardiff University*, 2020. [Online]. Available: https://orca.cardiff.ac.uk:134348

[2] R. Chippagiri, A. Bras, D. Sharma, and R. V. Ralegaonkar, "Technological and sustainable perception on the advancements of prefabrication in construction industry," *Energies*, vol. 15, no. 20, p. 7548, 2022. [Online]. Available: https://doi.org/10.3390/en15207548

[3] I. P. G. Sukaatmadja, "Factor affecting competitive advantage of real estate developers in indonesia," *Journal of Islamic Marketing*, vol. 12, no. 9, pp. 1950–1969, 2020. [Online]. Available: https://doi.org/101108/JIMA1-2020-0010

[4] X. Zhu and Y. Li, "Big data technology in real estate industry: Scenarios and benefits," *International Conference on Big Data*, pp. 70–79, 2022. [Online]. Available: https://doi.org/10.1007/978-3-031-23501-6_8

[5] S. T., "What is a valu chain analysis? 3 steps. harvard business review," *Harvard Business School*, 2020. [Online]. Available: https://online.hbs.edu/blog/post/what-is-value-chain-analysise

[6] C. Maududy and A. Gamal, "Literature review: technologies and property development," *IOP Publishing*, vol. 396, no. 1, p. 012020, 2019. [Online]. Available: https://doi.org/10.1088/1755-1315/396/1/012020

[7] K. Tochaiwat, "Subdivision project development," *Bangkok: Thammasat Press*, 2020.

[8] J. B. Quinn, "Technological forecasting. harvard business review," *Technological Forecasting*, 1967. [Online]. Available: https://hbr.org/1967/03/-forecastingtechnological

[9] T. S. Yearbook, "National statistics office," *Government of Malawi: Zomba, Malawi*, 2002. [Online]. Available: https://www.nso.go.th/public/e-book/Statistical-Yearbook/SYB-2020

[10] Q. He and Y. Zhang, "Residential locations and residential moves between the city centre and suburb in beijing, china," *Habitat International*, vol. 131, p. 102711, 2023. [Online]. Available: https://doi.org/10.1016/j.habitatint.2022.102711

[11] F. Sen and A. H. Rubenstein, "External technology and in-house r. & d's facilitative role," *Journal of Product Innovation Management*, vol. 6, no. 2, pp. 123–138, 1989. [Online]. Available: https://doi.org/10.1016/0737-6782(89)90006-4

[12] R. El-Azab, "Smart homes: Potentials and challenges," *Clean Energy*, vol. 5, no. 2, pp. 302–315, 2021. [Online]. Available: https://doi.org/10.1093/ce/zkab010

[13] W. house, "Modern home design: Innovations and trends to follow," 2024. [Online]. Available: https://shorturl.asia/ICKTh

[14] A. Zielonka, M. Wozniak, S. Garg, G. Kaddoum, M. J. Piran, and G. Muhammad, "Smart homes: How much will they support us? a research on recent trends and advances," *IEEE Access*, vol. 9, pp. 26 388–26 419, 2021.

[15] P. Tiwari, V. Garg, and R. Agrawal, "Changing world: Smart homes review and future," *Smart IoT for Research and Industry*, pp. 145–160, 2022. [Online]. Available: https://doi.org/10.1007/978-3-030-71485-7_9

[16] A. Pramono and T. Primadani, "Smart home apps for saving energy usage at griyapram guesthouse malang," *AIP Publishing*, vol. 2594, no. 1, 2023. [Online]. Available: https://doi.org/10.1063/5.0109445

[17] A. Belvcivc and S. Eloy, "Architecture for community-based ageing a shape grammar for transforming typical single-family houses into older people's cohousing in slovenia," *Buildings*, vol. 13, no. 2, p. 453, 2023. [Online]. Available: https://doi.org/10.3390/buildings13020453

[18] M. R. Fraune, T. Komatsu, H. R. Preusse, D. K. Langlois, R. H. Au, K. Ling, S. Suda, K. Nakamura, and K. M. Tsui, "Socially facilitative robots for older adults to alleviate social isolation: A participatory design workshop approach in the us and japan," *Frontiers in psychology*, vol. 13, p. 904019, 2022.

[19] M. Al-Taee, "Using surveying and computer techniques to calculate (ra) & (rmse) for digital map of technical institute/mosul," *Iraqi National Journal of Earth Science*, vol. 19, no. 2, pp. 1–0, 2019.

[20] Y. Chen, D. Zhu, Z. Tian, and Q. Guo, "Factors influencing construction time performance of prefabricated house building: A multi-case study," *Habitat International*, vol. 131, p. 102731, 2023.

[21] R. K. Madireddy, K. V. Alluri, V. Somepalli, T. Golakoti, and K. Sengupta, "Toxicological assessments of a proprietary blend of punica granatum fruit rind and theobroma cacao seed extracts: acute, subchronic, and genetic toxicity studies," *Journal of Toxicology*, vol. 2022, no. 1, p. 3903943, 2022. [Online]. Available: https://doi.org/10.1155/2022/3903943

[22] G. Sua-iam and N. Makul, "Potential future direction of the sustainable production of precast concrete with recycled concrete aggregate: A critical review," *Engineered Science*, vol. 28, p. 1075, 2024. [Online]. Available: https://doi.org/10.30919/es1075

[23] N. Kaja and A. Jauswal, "Review of precast concrete technology in india," *International Journal of Engineering Research & Technology*, vol. 10, no. 6, pp. 867–872, 2021.

[24] K. Tochaiwat, "Reducing greenhouse gas emissions in the construction of real estate projects," *The Consulting Engineers Association of Thailand Journal CEAT Journal*, pp. 47–54, 2023.

[25] R. W. Wong and B. P. Loo, "Sustainability implications of using precast concrete in construction: An in-depth project-level analysis spanning two decades," *Journal of Cleaner Production*, vol. 378, p. 134486, 2022. [Online]. Available: https://doi.org/10.1016/j.jclepro.2022.134486

[26] R. Masood and K. Roy, "Review on prefabricated building technology," *Technology*, vol. 4, pp. 24–30, 2022. [Online]. Available: https://doi.org/10.34074/scop.6004002

[27] H. Al-Khaiat and S. M. Fereig, "The role of precast concrete systems in kuwaiti housing projects: In-depth analysis of kuwaiti precast concrete industry—advantages and limitations of each system outlined," *Building research and information*, vol. 24, no. 6, pp. 374–378, 1996. [Online]. Available: https://doi.org/10.1080/09613219608727559

[28] A. M. Abdelmoneim, M. Albattah, and A. AlMuhairi, "Single users' perception towards acceptance of precast technology in the construction industry: Case of abu dhabi, uae," *9th Zero Energy Mass Custom Home International Conference (ZEMCH 2022)*, pp. 831–839, 2022.

[29] I. Siksnelyte-Butkiene, E. K. Zavadskas, and D. Streimikiene, "Multi-criteria decision-making (mcdm) for the assessment of renewable energy technologies in a household: A review," *Energies*, vol. 13, no. 5, p. 1164, 2020. [Online]. Available: https://doi.org/10.3390/en13051164

[30] D. Marikyan, S. Papagiannidis, and E. Alamanos, "Smart home sweet smart home: An examination of smart home acceptance," *International Journal of E-Business Research (IJEBR)*, vol. 17, no. 2, pp. 1–24, 2021. [Online]. Available: https://doi.org/10.4018/IJEBR.2021040101

[31] M. Albany, E. Alsahafi, I. Alruwili, and S. Elkhediri, "A review: secure internet of thing system for smart houses," *Procedia Computer Science*, vol. 201, pp. 437–444, 2022. [Online]. Available: https://doi.org/10.1016/j.procs.2022.03.057

[32] L. Y. Rock, F. P. Tajudeen, and Y. W. Chung, "Usage and impact of the internet-of-things-based smart home technology: a quality-of-life perspective," *Universal access in the information society*, vol. 23, no. 1, pp. 345–364, 2024. [Online]. Available: https://doi.org/10.1007/s10209-022-00937-0

[33] D. Ahmed, M. Kamal, and R. Alsaigh, "Design and implement an application to measure the readiness of teachers to adopt e-learning in mosul schools after pandemic covid-19," *Al-Rafidain Journal of Computer Sciences and Mathematics*, vol. 16, no. 1, pp. 41–50, 2022. [Online]. Available: https://ddl.ae/book/8237389

[34] N. Liang and M. Yu, "Research on design optimization of prefabricated residential houses based on bim technology," *Scientific*

Programming, vol. 2021, no. 1, p. 1422680, 2021. [Online]. Available: https://doi.org/10.1155/2021/1422680

[35] J. Mang, R. Zainal, and I. S. M. Radzuan, "Influence of location attributes on home buyers 'purchase decision," *International Journal of Supply Chain Management*, vol. 7, no. 3, pp. 94–100, 2018. [Online]. Available: https://doi.org/10.1063/1.5055480

[36] K. Grønhaug, I. A. Kleppe, and W. Haukedal, "Observation of a strategic household purchase decision," *Psychology & Marketing*, vol. 4, no. 3, pp. 239–253, 1987. [Online]. Available: https://doi.org/10.1002/mar.4220040307

[37] H. Ismail and S. M. Shaari, "The location, house, or neighbourhood choice preferences among malaysian housing generations," *Journal of Surveying, Construction and Property*, vol. 11, no. 2, pp. 64–74, 2020. [Online]. Available: https://doi.org/10.22452/jscp.sp2020no1.6

[38] M. L. Markus, "Finding a happy medium: Explaining the negative effects of electronic communication on social life at work," *ACM Transactions on Information Systems (TOIS)*, vol. 12, no. 2, pp. 119–149, 1994. [Online]. Available: https://doi.org/10.1145/196734.196738

[39] Y. Zelenkov and E. Lashkevich, "Does information and communication technology really affect human development? an empirical analysis," *Information Technology for development*, vol. 29, no. 2-3, pp. 329–347, 2023. [Online]. Available: https://doi.org/10.1080/02681102.2022.2081116

[40] J. M. Barrero, N. Bloom, and S. J. Davis, "The evolution of work from home," *Journal of Economic Perspectives*, vol. 37, no. 4, pp. 23–49, 2023.

[41] M. Zhang, Z. Li, H. Si, L. Cheng, X. Zhou, and B. Wang, "Urban travel time and residential location choice: The impacts of traffic congestion," *Sustainable Cities and Society*, vol. 99, p. 104975, 2023. [Online]. Available: https://doi.org/10.1016/j.scs.2023.104975

[42] T. Magara and Y. Zhou, "Internet of things (iot) of smart homes: privacy and security," *Journal of Electrical and Computer Engineering*, vol. 2024, no. 1, p. 7716956, 2024. [Online]. Available: https://doi.org/10.1155/2024/7716956

[43] N. Kapucu and M. Bilim, "Internet of things for smart homes and smart cities," *Springer*, pp. 331–356, 2023. [Online]. Available: https://doi.org/10.1007/978-3-031-38506-3_13

[44] L. Vasilevska, P. Vranic, and M. Vasilevska, "Evaluating the relationship between urban redevelopment of large housing estates and urban green space based on gis–mcdm approach: Empirical experience from nis, serbia," *Journal of Urban Planning and Development*, vol. 148, no. 2, p. 05022005, 2022. [Online]. Available: https://doi.org/10.1061/(ASCE)UP.1943-5444.0000790.

[45] O. Taiwo, "Gis-mce based suitability analysis for sustainable estate development in ede north lga osun state, nigeria," *Journal of Applied Science and Technology Trends*, vol. 5, no. 01, pp. 18–28, 2024. [Online]. Available: https://doi.org/10.38094/jastt501181

[46] A. Dawidowicz and M. Dudzińska, "The potential of gis tools for diagnosing the sfs of multi-family housing towards friendly cities—a case study of the eu member state of poland," *Sustainability*, vol. 14, no. 11, p. 6642, 2022. [Online]. Available: https://doi.org/10.3390/su14116642

[47] A. Djan, J. Oluwoye, and A. Ouf, "Gis-based corporate real estate assets management: A conceptual framework," *Global Journal of Research in Business Management*, vol. 4, no. 01, pp. 43–50, 2024. [Online]. Available: https://doi.org/10.5281/zenodo.10825743

[48] A. Mohammad, S. Ali, and R. Fathi, "Using remote sensing techniques and gis to study of pm2. 5 and pm10 concentrations in the atmosphere of mosul city, iraq," *Iraqi National Journal of Earth Science*, vol. 22, no. 1, pp. 15–26, 2022. [Online]. Available: https://doi.org/10.33899/earth.2022.174661

[49] F. A. Ibrahim, N. Ishak, J. K. Y. Woon, W. Boying, M. W. M. Shafiei, R. Ismail, and R. A. Razak, "Virtual technology (vr) attractiveness attributes in influencing house buyers' intention to purchase," *Journal of Advanced Research in Applied Sciences and Engineering Technology*, vol. 29, no. 2, pp. 126–134, 2023. [Online]. Available: https://doi.org/10.37934/araset.29.2.126134

[50] F. Zulkifli and H. Ismail, "Factors influencing house buyer's decision in malaysia. case study: Sepang, selangor," *Planning Malaysia*, vol. 21, 2023. [Online]. Available: https://doi.org/10.21837/pm.v21i27.1293

[51] C. L. Cheam, Z. Ismail, P. N. R. A. M. Zulkifli, N. A. Baharuddin, and N. A. A. Aziz, "The determinants of house buyers'purchase decisions in kota bharu, kelantan," *Planning Malaysia*, vol. 21, 2023. [Online]. Available: https://doi.org/10.21837/pm.v21i25.1253

[52] A. Samudro, H. Hamdan, and I. Raharja, "Home purchase decisions: An analysis of location, promotion, and price of housing in indonesia," *Dinasti International Journal of Management Science (DIJMS)*, vol. 5, no. 5, pp. 1027–1036, 2024.

[53] R. Rahmawati, I. Ismartaya *et al.*, "The effect of product design, promotion and location on the purchase decision on the green java housing, kemang bogor," *International Journal of Management Analytics*, vol. 1, no. 2, 2024. [Online]. Available: https://doi.org/10.59890/ijma.v1i2.320

[54] G. Sudrajad and J. Sutanto, "The influence of the application of marketing mix on the purchase decision of prospective consumers of grand cempaka housing," *KnE Social Sciences*, pp. 140–151, 2020. [Online]. Available: https://doi.org/10.18502/kss.v4i3.6391

[55] M. Sembiring, "Model analysis of purchase decision," *Dinasti International Journal of Management Science*, vol. 1, no. 3, pp. 390–406, 2020. [Online]. Available: https://doi.org/10.31933/dijms.v1i3.162

[56] G.-P. Lovicu, J. Lim, A. Faferko, A. Gao, A. Suthakar, D. Twohig *et al.*, "Fixed-rate housing loans: Monetary policy transmission and financial stability risks— bulletin–march 2023," *Reserve Bank of Australia*, 2023.

[57] W. Ashour and W. Sultan, "Classification of the financial reality of the national insurance company for the period (2008-2015) using cluster analysis," *Al-Rafidain Journal of Computer Sciences and Mathematics*, vol. 14, no. 2, pp. 25–37, 2020. [Online]. Available: http://csmj.mosuljournals.com

[58] C. Okoro and N. Umeokafor, "A review of technology application and benefits in comprehensive facilities management for housing quality assurance," 2023. [Online]. Available: http://gala.gre.ac.uk/id/eprint/42969

[59] S. Kaewunruen, J. Sresakoolchai, and L. Kerinnonta, "Potential reconstruction design of an existing townhouse in washington dc for approaching net zero energy building goal," *Sustainability*, vol. 11, no. 23, p. 6631, 2019. [Online]. Available: https://doi.org/10.3390/su11236631

[60] J. W. Creswell and J. D. Creswell, "Research design: Qualitative, quantitative, and mixed methods approaches," *Sage publications*, 2014.

How to cite this article:
Kongkoon Tochaiwat, Anuwat Budda, and Patcharida Seniwong (2025). 'Forecasting technologies impacting real estate business during the transition to 2030s', Al-Qadisiyah Journal for Engineering Sciences, 18(1), pp. 092-098. https://doi.org/10.30772/qjes.2025.155895.1450