



Analysis and Design Geographic Information System (GIS) Based Platform For Property Marketplace

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Abstract. This paper examines the growth and transformation of the Indonesian real estate sector, highlighting the challenges faced by potential buyers due to the absence of a Geographic Information System (GIS)-based platform. To address this issue, the study proposes the development of a GIS-based property market information system that incorporates user-centered design principles and GIS technology. By employing the Design Thinking approach, the research aims to enhance the efficiency and effectiveness of property market systems in Indonesia, facilitating informed decision-making for buyers. The platform will provide users with organized property details including prices, facilities, and locations. The outcomes of this study will contribute to the advancement of real estate industry knowledge and offer valuable insights for practitioners.

Keywords: *Geographic Information System, GIS, Property Market, Design Thinking Methodology.*

1 Introduction

1.1 Background

The real estate sector in Indonesia has undergone significant transformations due to economic growth, urbanization, and changing demographics. Indonesia, as the largest economy in Southeast Asia, offers diverse opportunities in its real estate markets [1], [2], [3]. Figure 1 shows the quarterly growth trends in the real estate industry [4].

Tren Data Pertumbuhan Industri Real Estate (Properti), 2011 - 2023

Deskripsi	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023*
PDB Industri Real Estate (Miliar rupiah)	196.214	211.441	229.254	244.218	256.440	266.980	279.201	289.569	299.648	316.901	324.229	333.283	339.015	84.983
Pertumbuhan Industri Real Estate (Properti) Tahunan		7,68%	7,41%	6,54%	5,00%	4,11%	4,00%	3,60%	3,48%	5,76%	2,30%	2,78%	1,72%	0,37%

Sumber: DataIndustri Research, dibuat dari Badan Pusat Statistik (BPS) dan Bank Indonesia (BI)
PDB (Produk Domestik Bruto) Atas Dasar Harga Konstan 2010
*Kuartal 1 2023, pertumbuhan terhadap PDB Industri real estate kuartal 1 2022 yang sebesar 84.668,9 miliar rupiah

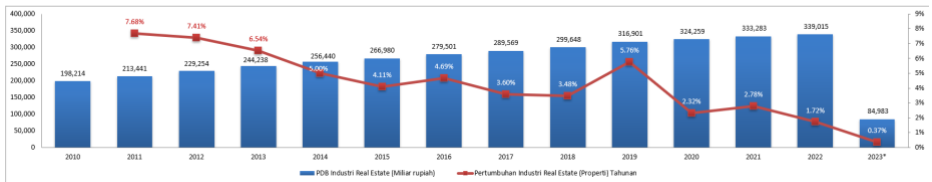


Figure 1. Real Estate Industry Growth Trends (Y on Y)

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S. Musa et al. (eds.), *Proceedings of the 5th International Conference on Global Innovation and Trends in Economy 2024 (INCOGITE 2024)*, Advances in Economics, Business and Management Research 302,

https://doi.org/10.2991/978-94-6463-585-0_25

In the first quarter of 2023, the real estate sector demonstrated positive quarterly growth, as shown in Figure 1. The sector’s annual performance up until Q1, 2023 also experienced positive performance compared to the previous year, which is shown in Figure 2.

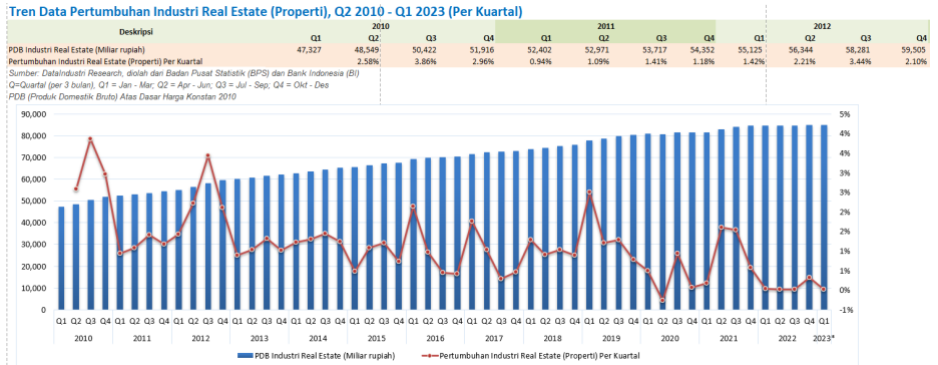


Figure 2. Real Estate Industry Growth Trends (Q on Q)

The data on real estate industry growth from 2011 to 2023 in Indonesia, as depicted in Figure 1 and Figure 2, provide valuable insights for business professionals, investors, and academics for conducting business analysis and developing effective strategies [4].

The foundation for Indonesia’s real estate sector was laid in the early 2000s when the government reforms and relaxed foreign ownership regulations, attracting both local and international investors [5], [6]. This led to a construction explosion in major cities like Jakarta, Surabaya, and Bandung, with the development of residential complexes, commercial buildings, and industrial parks.

The Indonesian government has been proactive in promoting the real estate sector through policies supporting infrastructure development [7], [8], [9], [10]. These initiatives have improved connectivity and unlocked new investment opportunities in various regions.

Advancements in technology and globalization have enabled online real estate transactions but acquiring detailed information about properties remains challenging in Indonesia [11], [12]. Well-known property websites, including rumah123, rumah.com, Trovit, Jendela360, Lamudi, OLX, rumahku.com, and 99.co.id, employ a filtering system for property searches, and this method has its limitations.

The increasing adoption of Geographic Information System (GIS) technologies, especially in geo-analytics and integrated, location-based data services has led to a rise in demand for GIS solutions. The service segment is expected to experience heightened demand, driven by the utilization of spatial data analytics in various applications [13], [14]. GIS-based platforms offer a potentially more effective system for property market management, although it is not currently used by most of the property websites in Indonesia.

Following the increasing trend of the GIS market by components, this research focuses on analysis and designing GIS-based platforms for the real estate sector to enhance property searching efficiency. The platforms allow users to know the ideal prices of the property according to the property’s location, conditions, and nearest

facilities. Furthermore, the users can see all properties for sale and rent in an area with map visualization functionality on the platform, which enhances property searching efficiency. ***Additionally, this research will include the study to investigate further the potential of a GIS-based property platform utilization for property market information system development.

2 Literature Review

This section provides information about GIS in general along with several examples of previous GIS implementation projects as well as the technologies and tools used during the development process of GIS for property market prototype.

2.1 Theoretical Perspectives

Theoretical perspectives related to the technology and tools used during the research works for the GIS-based platform follow. GIS is a powerful tool for analyzing and visualizing spatial data, enabling users to integrate diverse data sources and create maps for data organization and analysis [15]. Microsoft Access is a widely used and user-friendly tool for database management, which will be employed in this research to create the Entity Relationship Diagram (ERD) and establish relationships for the GIS platform [16]. Microsoft Excel enables data manipulation, analysis, chart or graph creation, and complex calculations. It can be used to obtain statistical data on properties in South Jakarta, especially Kebayoran Baru for the GIS-based platform, using a dummy file [17]. OpenStreetMap (OSM) provides map images that can be downloaded in various formats (PNG, JPEG, SVG, PDF), facilitating the visualization of specific areas or property locations [18]. Figma is utilized to create design mock-ups, wireframes, and prototypes for the GIS-based platform, taking advantage of its versatile design and collaboration features [19].

2.2 Related Works

Related works and their significance are briefly explored, particularly in the context of GIS.

In a study conducted by Alesheikh et al., the evolution of web-based GIS is explored, the technology aiming to improve decision-making through spatial information dissemination. This research assesses the current progress of GIS in modeling and proposing improvement procedures to leverage the internet for various information system functions [20].

Lü et al. utilizes GIS as an information system to enhance understanding of geography, distribution patterns, and evolutionary processes. The perspective here is that it empowers users with powerful problem-solving capabilities by analyzing the interactions of geographic elements and the dynamics of their relationship [21].

Yomralioglu draws attention to the underutilization of arrival rearrangement in effectively managing land-use changes from rural to urban areas. This hindrance limits the shared benefits for the government and landowners [22].

Malczewski explores the significance of distribution where using web-based scientific visualization tools, electronic libraries, and databases are emphasized. This approach is contrasted with the automated approach, highlighting the importance of web-based tools [23].

The HomeSeeker system is an interactive visual analytics system designed to assist users in the local real estate market. It enables users to browse, filter, and compare properties, as well as discover hidden patterns in location-based data [24].

The implementation of the Real Estate Regulatory Authority Act (RERA), which has brought significant changes, along with the potential of using RERA data to develop a digital platform for informed purchasing decisions in the Indian property market has been explored [25].

The impact of technology and social media on the real estate industry has been assessed, emphasizing the continued importance of REALTORS® expertise and the widespread use of the Internet and mobile devices for home searching [26].

Gao et al. propose a location-centric prediction framework that utilizes detailed location profiles from various data sources to accurately forecast home prices. This framework caters to the needs of homeowners, buyers, investors, and realtors [27].

The significance of spatiotemporal events, such as crime, wildfires, accidents, infectious diseases, and human interactions with mobile devices, is emphasized by Silva et al. These events are recorded with detailed geographic location, time, and associated attributes, providing valuable insights [28].

3 Methodology

Design thinking is a concept and approach that combines multiple disciplines and begins with understanding user needs with the goal of satisfying those needs [29]. It focuses on task-based workflow and explores divergent and creative paths for problem-solving [30], [31]. There are five phases, including the empathize, define, ideate, prototype, and testing phase.

The first phase of the design thinking methodology is empathize, which involves conducting preliminary research to understand user needs and identify existing problems in real estate websites in Indonesia [31], [32], [33]. Most property websites in Indonesia face issues such as incomplete information and inefficient viewing of property locations, requiring users to navigate through multiple clicks and external links to access detailed information and compare properties in the same area.

The Define phase, the second phase, aims to establish requirements based on the problems identified in the empathize phase [31], [32], [33], ensuring to meet user needs. The requirements to address the problem include displaying detailed property information, incorporating interactive maps, enabling property comparison, and providing a user-friendly interface for location-based property searching.

Phase three, the Ideation phase, involves generating innovative and creative solutions through brainstorming, mind mapping, and rapid prototyping based on user needs and defined requirements [31], [32]. The subsequent step is to build an interactive GIS-based platform that aligns with the identified requirements from the Define Phase.

The Prototyping phase is a crucial step in design thinking where an initial version of a product or service is created, tested, refined, and iterated based on feedback [31], [32], by enabling an iterative mock-up and user-centric design process for a more effective end product.

The last phase in design thinking is the testing phase; this phase of the design thinking process aims to gather feedback and evaluate the prototype [32], allowing for refinement and improvement. In this research, feedback will be collected through interviews with knowledgeable stakeholders to ensure credible input for creating a user-centric and effective final product.

4 Result and Discussion

4.1 Previous Work Analysis For Property Websites And Applications

This section provides an analysis of various property websites and applications. Rumah.com offers a user-friendly interface, advanced search options, and property alerts [2]. Rumah123.com provides property news, articles, and advanced search options [34]. Lamudi offers mobile apps and property alerts [35]. OLX has a large user base, user-friendly interface, and extensive property selection [36]. Website 99.co/id offers advanced search options and a map view feature [37]. Trovit aggregates property listings from various sources [38]. Jendela360 provides virtual tours and property management tools [39]. Rumahku.com offers property news, articles, and advanced search options [40]. Pinhome features an intuitive layout, effortless property search, and property alerts [41]. Rightmove.co.uk offers advanced search options, interactive maps, a mortgage calculator, and local area information [42].

4.2 Diagrams for GIS-based Platform

Use Case Diagram to Illustrate the Functionality of the Platform

The Use Case Diagram is a tool in software development that visually represents the functionality and interactions of a platform from a user's perspective. It showcases the involved actors, including buyers, investors, sellers, marketing agents, marketing companies, and Admin, along with key tasks such as Register, Login, Browse Property, List Property, Manage Property Information, and Statistic Data for Property Geo-information analysis.

Architecture Diagram for the GIS-based Property Platform System

The architecture diagram in Figure 3 for the GIS-based Property Platform System provides an overview of the input, process, and output of the platform.

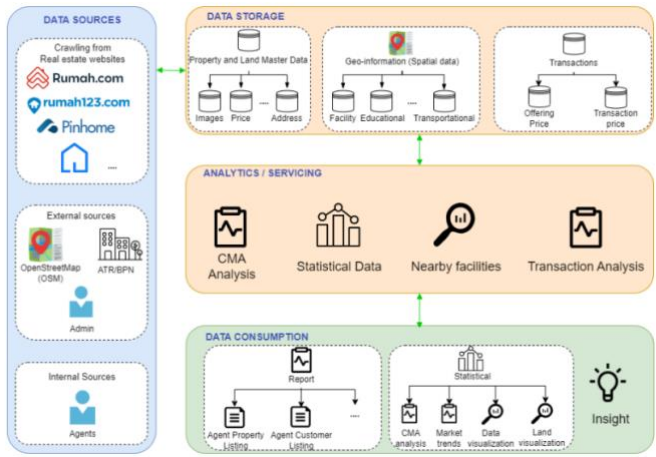


Figure 3. Architecture Diagram

Figure 3 illustrates the architecture diagram of the GIS-based Property Market Information System, showcasing its various components and layers including Data Sources, Data Storage, Analytics/Servicing, and Data Consumption.

Data sources refer to the various external and internal origins from which data is collected. External sources involve crawling existing property websites using OpenStreetMap (OSM), government sources (ATR/BPN), and accessing admin databases. At the same time, internal sources pertain to data obtained from agent databases.

The collected data is stored in one of three databases, based on its information type. The first database, Property and Land Master Data, contains essential property attributes such as property images, prices, land area, building area, property type, address, and descriptions. The second database, Geo-information or Spatial Data, includes property coordinates and information about nearby facilities like transportation (MRT stations, bus stations, rail stations), educational facilities, shopping centers, and other amenities. Lastly, the Transaction Data database holds information on the offering and transaction prices of the properties.

The collected data is subject to a meticulous analytics or servicing process. Firstly, a Comparative Market Analysis (CMA) is conducted to assess and compare property values based on similar properties in the market. It helps in determining appropriate pricing strategies. These analyses provide a deeper understanding of the property market dynamics, allowing for more informed user decision-making.

Entity Relationship Diagram to Store the Relationship of Each Entity

The ERD serves as a blueprint for the GIS-based platform, offering a comprehensive understanding of its data model and logical structure. The diagram includes tables for Property, Property Type, User, Marketing Agent, Marketing Company, Marketing Employee, Province, City, Sub-district, Urban Village, and Streets in South Jakarta. Notably, the diagram emphasizes the presence of prevalent one-to-many relationships.

4.3 Manual CMA Value Determining Using Dummy File Analysis

This research aims to develop a practical manual approach for determining Comparative Market Analysis (CMA) values using a dummy file from properties websites. The proposed method provides an alternative for real estate professionals when actual market data is limited or unavailable, allowing them to obtain approximate CMA values.

Data Collection Conduct Manually by the Admin

Figure 4 visually outlines the data collection process undertaken by the Admin to determine the CMA value.

Alamat	Harga Penawaran	Luas Tanah	Luas Bangunan	Harga Bangunan	Harga Tanah tanpa ba
Jalan Senopati, Jakarta Selatan	18,900,000,000	738	950	950,000,000	17,950,000,000
Jalan Senopati, Jakarta Selatan	28,000,000,000	330	400	400,000,000	27,600,000,000
Jalan Senopati, Jakarta Selatan	26,000,000,000	412	350	350,000,000	25,650,000,000
Jalan Senopati, Jakarta Selatan	14,000,000,000	245	200	1,600,000,000	12,400,000,000

Figure 4. Data collection conducted manually by the Admin

Figure 4 showcases important information such as property address, offering price, land area, and building area, which are crucial inputs for the subsequent analysis and valuation procedures.

Property Grouping Based on Condition

Figure 5 provides a visual representation of property categorization based on building condition, showcasing the respective price ranges within each class.

	Kelas Properti					
	Tanah	Bangunan Lama (Renovasi)	Bangunan Lama (Baik)	Bangunan Baru	Bangunan Baru Mewah	Bangunan Baru Super Mewah
	0	1,000,000	3,000,000	6,000,000	8,000,000	10,000,000
33		x				
54		x				
32		x				
15					x	

Figure 5. Property grouping based on condition

The classification aids in understanding dataset variations and facilitates targeted analysis. The classes include "Tanah" for land, "Bangunan Lama (renovasi)" for old building requiring renovation, "Bangunan Lama (baik)" for well-maintained old building, "Bangunan Baru Mewah" for luxury new building, and "Bangunan Baru Super Mewah" for super luxury new building, with corresponding price ranges indicating the features and conditions of each property type.

Calculation for Determining Land Area Per Square Meter

Figure 6 illustrates the calculation process for determining the land price per square meter, encompassing variables such as building price, land price without buildings, and land price per square meter.

an	Harga Bangunan	Harga Tanah tanpa bangunan	Harga Tanah per m2	Ta
	950,000,000	17,950,000,000	24,322,493	
	400,000,000	27,600,000,000	83,636,364	
	350,000,000	25,650,000,000	62,257,282	
	1,600,000,000	12,400,000,000	50,612,245	

Figure 6. Calculation procedure for determining land area per square meter

This calculation method for evaluating property values aids in making well-informed decisions within the real estate market, providing an accurate estimation of the land's approximate value.

4.4 Figma Mock-up Design

Login and Register Page

The Login Page serves as the entry point for registered users, allowing them to authenticate their identity and gain personalized access to platform features and services. While the Register Page provides users with the ability to create an account.

Home Page

The Home Page, see Figure 7, is serving as the initial point of entry for users.

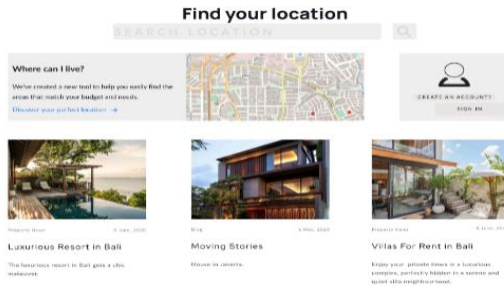


Figure 7. Home Page

Figure 7 illustrates the Home Page design of the GIS-based property platform, displaying a user-friendly interface. It includes a "Search Location" button for property searches and an "Inspire" feature for Indonesian property news. Users can utilize the "Discover Your Perfect Location" button to access the Map Page, facilitating location-based property searches and proximity to essential facilities.

Header

The header section of the GIS-based property platform includes various menus and elements to enhance user navigation and provide valuable resources, as shown in Figure 8.



Figure 8. Header

The "Buy" menu allows users to explore available properties for sale and provides easy access to property search, new home exploration, location-suitability assessment, and property valuation. Similarly, the "Rent" menu caters to individuals interested in rental properties, offering search options, student accommodations, and information on suitable residential areas. The "House Prices" menu provides insights into property valuation, market trends, and sold house prices, empowering users to make informed decisions about property values within specific locations. The "Find Agent" menu enables users to connect with real estate agents for property assistance, while the "Commercial" menu facilitates efficient searches for commercial properties for rent or sale, including the option to advertise commercial properties. Lastly, the "Inspire" menu offers a wealth of information and resources on real estate topics in Indonesia, including property blogs, news articles, trends, and guides, supporting users in making informed decisions within the local real estate market.

Search Page

Figure 9 showcases the user-friendly Search Page design, featuring customizable fields for location, property type, search radius, price range, and number of bedrooms.

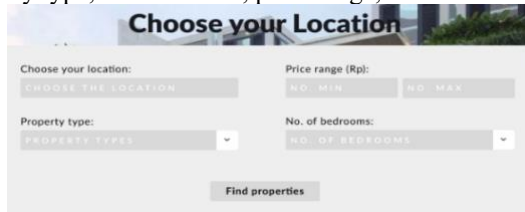


Figure 9. Search Page

This design empowers users to input their desired criteria, facilitating efficient property searches tailored to their preferences.

Search Page for Available Properties in Listed Design

Figure 10 illustrates the Search Page interface, enabling users to efficiently explore a comprehensive list of available properties based on their specified location for rental or sale.

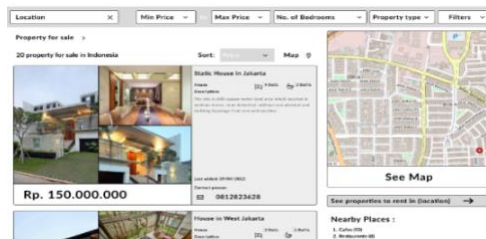


Figure 10. Search Page for Available Properties in listed design

This user-friendly page presents property listings with detailed information, including photographs, location details, property types, prices, and more. Users can further enhance their viewing experience by utilizing the map view option or accessing a dedicated map page, providing a visual exploration of property listings and supporting informed decision-making.

Search Page in Listed Design based on the Number of Bedrooms

The Search Page on the property platform includes a feature based on the number of bedrooms.



Figure 11. Search Page in listed design based on the number of bedrooms

Figure 11 showcases the interface allowing users to specify the desired number of bedrooms for their property search. This feature enables users to efficiently narrow down their property options and improve the search process.

Search Page in Listed Design based on the Property Type

The "Property Type" button provides users with the ability to choose the appropriate property type based on their preferences and requirements.

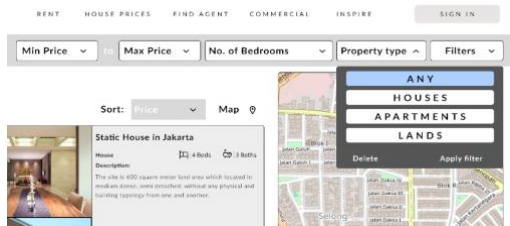


Figure 12. Search Page in listed design based on the property type

Figure 12 showcases the interface allowing users to specify the desired property type for their property search.

Search Page in Listed Design based on the User’s Filters for the Properties

Figure 13 presents the "Filter" button, a feature of the property platform's Search Page, enabling users to customize and refine their search experience by inputting specific property details and applying filters.

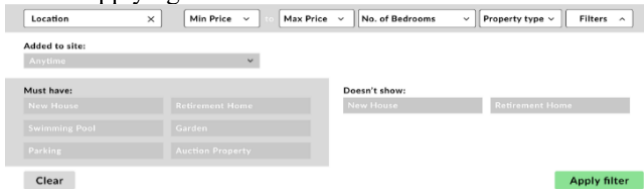


Figure 13. Search Page in listed design based on the filter for the properties

This functionality empowers users to streamline their search process and obtain more relevant and suitable property listings based on their preferences and requirements.

Map Page

Figure 14 presents the Map Page of the GIS-based property platform, allowing users to visually explore property locations and interact with markers or the “blue pin.”



Figure 14. Map Page

This page showcases the display of available properties within a specific area, offering filtering options based on price range to refine search results according to user preferences and budget constraints. This filtering functionality enhances the effectiveness of the property search process, enabling users to efficiently discover properties that align with their price criteria.

Map Page with the Property Details

Figure 15 presents the Map Page with property detail that serves as a feature in the property platform, offering users a visually interactive way to explore properties and access comprehensive information.

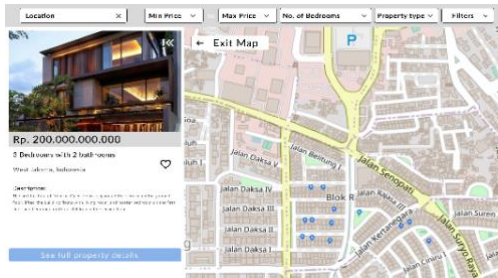


Figure 15. Map Page with property details

By clicking on corresponding "blue pins," this streamlined approach presents essential property details, enabling users to evaluate suitability before further actions or inquiries.

Full Property Detail Page

Figure 16 displays a comprehensive Property Detail Page, accessible through the "See full property details" option, as depicted in Figure 15.

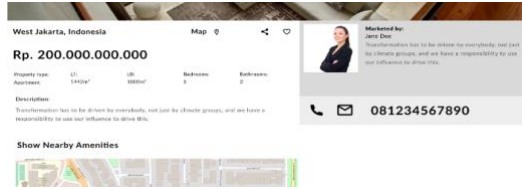


Figure 16. Full Property Detail Page

This page offers essential information such as location, price, land area (LT), building area (LB), bathrooms, bedrooms, and contact details of the agent or seller. By presenting these details in a centralized manner, users can make informed decisions and establish direct communication with the relevant parties involved.

Nearby Page

Figure 17 showcases the "Nearby Places" feature of the platform, enabling users to access property information and explore nearby facilities.

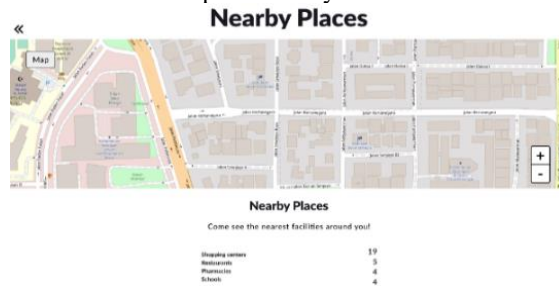


Figure 17. Nearby Page

This feature provides valuable information about amenities such as restaurants, schools, shopping centers, and gyms in proximity to a specific property location. It assists users in assessing the convenience and accessibility of essential facilities, aiding them in making informed property decisions.

4.5 User Interview Findings and Summary

Property agents emphasize the importance of location and the number of rooms as primary factors influencing property sales, with additional considerations such as layout, orientation, and nearby amenities for buyers with higher budgets.

Agents gather property market information through various sources, including property portals, databases, direct canvassing, and collaboration with fellow agents, ensuring data accuracy and reliability. Marketing strategies involve banners on unoccupied properties and advertisements on property portals. While the GIS-based platform is not yet widely adopted, its potential benefits include time-saving data gathering, accurate market prices, and route information.

A user questionnaire seeks insights from property market stakeholders to inform the development of GIS-based property market information systems and enhance the Indonesian property market.

5 Conclusion

The real estate sector in Indonesia has experienced significant growth due to various factors, offering diverse opportunities for different segments and consumer preferences [4]. A GIS-based property platform presents an efficient solution for managing the market and enhancing website systems, providing valuable information about property details and the surrounding environment, and this study presents a specific design for a user-friendly platform utilizing GIS technology to improve decision-making processes and to assess the feasibility of incorporating Design Thinking principles. Overall, the GIS-based property platform enhances the real estate experience for buyers, sellers, agents, and investors by simplifying the process and meeting user requirements effectively.

References

1. MordorIntelligence, "Indonesia Residential Real Estate Market Size & Share Analysis - Industry Research Report - Growth Trends." [Online]. Available: <https://www.mordorintelligence.com/industry-reports/residential-real-estate-market-in-indonesia>
2. Rumah.com, "Bisnis Properti Asia Tenggara Bagus Hingga 10 Tahun Ke Depan, Terlebih Vietnam dan Indonesia." [Online]. Available: <https://www.rumah.com/berita-properti/2023/5/208731/bisnis-properti-asia-tenggara-bagus-hingga-10-tahun-ke-depan-terlebih-vietnam-dan-indonesia>
3. Statista, "Topic: Real estate in Indonesia," Statista. Accessed: Jun. 09, 2023. [Online]. Available: <https://www.statista.com/topics/8596/real-estate-in-indonesia/>
4. DataIndustri, "Data Pertumbuhan Industri Properti di Indonesia, 2011 - 2023." [Online]. Available: <https://www.dataindustri.com/produk/tren-data-pertumbuhan-industri-real-estate-properti/>
5. Antaranews, "Industri properti di Indonesia alami peningkatan selama 2022," Antara News. Accessed: Jun. 09, 2023. [Online]. Available: <https://www.antaranews.com/berita/3259825/industri-properti-di-indonesia-alami-peningkatan-selama-2022>
6. BPK RI, "PP No. 31 Tahun 2022 tentang Kepemilikan Modal Asing pada Perusahaan Efek [JDIH BPK RI]." Accessed: Jun. 09, 2023. [Online]. Available: <https://peraturan.bpk.go.id/Home/Details/225498/pp-no-31-tahun-2022>
7. Acclime, "New Regulations Aim to Ease FDI in Indonesia," Acclime Indonesia. [Online]. Available: <https://indonesia.acclime.com/news/easing-fdi/>
8. DEPHUB, "Bandara Baru Kediri : Proyek Pertama Bandara dengan Pembiayaan Swasta Murni Ditandatangani Kementerian Perhubungan Republik Indonesia." [Online]. Available: <https://dephub.go.id/post/read/bandara-baru-kediri---proyek-pertama-bandara-dengan-pembiayaan-swasta-murni-ditandatangani>
9. ekon, "Pemerintah Dukung Pengembangan Sektor Properti untuk Penyediaan Hunian yang Layak bagi Masyarakat - Kementerian Koordinator Bidang Perekonomian Republik Indonesia." [Online]. Available: <https://www.ekon.go.id/publikasi/detail/3753/pemerintah-dukung-pengembangan-sektor-properti-untuk-penyediaan-hunian-yang-layak-bagi-masyarakat>
10. P. KOMINFO, "Dorong Investasi Sektor Properti, Pemerintah Keluarkan Paket Kebijakan," Website Resmi Kementerian Komunikasi dan Informatika RI. [Online]. Available: <http://content/detail/19432/dorong-investasi-sektor-properti-pemerintah-keluarkan-paket-kebijakan/0/berita>

11. BI, "Survei Harga Properti Residensial Triwulan IV 2022." [Online]. Available: https://www.bi.go.id/id/publikasi/ruang-media/news-release/Pages/sp_253923.aspx
12. TheIconomics, "Rumah.com: Indeks Harga Properti Kuartal III Naik," Iconomics. [Online]. Available: <https://www.theiconomics.com/art-of-execution/rumah-com-indeks-harga-properti-kuartal-iii-naik/>
13. Grand Review Research, "Geographic Information System Market Size | GIS Industry Report, 2025." Accessed: Jan. 20, 2023. [Online]. Available: <https://www.grandviewresearch.com/industry-analysis/geographic-information-systems-market>
14. P. Yue and L. Jiang, "BigGIS: How big data can shape next-generation GIS," *2014 The 3rd International Conference on Agro-Geoinformatics, Agro-Geoinformatics 2014*, Sep. 2014, doi: 10.1109/Agro-Geoinformatics.2014.6910649.
15. A. McNamee, "What Is GIS and How Can It Benefit My Project? | Carroll Engineering," Carroll. Accessed: Jan. 05, 2023. [Online]. Available: <https://carrollengineering.com/what-is-gis-and-how-can-it-benefit-my-project/>
16. VisualParadigm, "Use Case Diagram." [Online]. Available: <https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-use-case-diagram/>
17. Microsoft Excel, "Microsoft Excel Spreadsheet Software | Microsoft 365." Accessed: Jun. 09, 2023. [Online]. Available: <https://www.microsoft.com/en-us/microsoft-365/excel>
18. OSM, "Tentang OpenStreetMap (OSM) – Perkumpulan OpenStreetMap Indonesia." [Online]. Available: <https://openstreetmap.or.id/tentang-openstreetmap/>
19. Figma, "Figma," Figma: the collaborative interface design tool. [Online]. Available: <https://www.figma.com/>
20. A. Alesheikh et al., "Web GIS: Technologies and its applications," Oct. 2022.
21. G. Lü, M. Batty, J. Strobl, H. Lin, A.-X. Zhu, and M. Chen, "Reflections and speculations on the progress in Geographic Information Systems (GIS): a geographic perspective," *International Journal of Geographical Information Science*, vol. 33, no. 2, pp. 346–367, Feb. 2019, doi: 10.1080/13658816.2018.1533136.
22. [22] T. Yomralioglu, "A Nominal Asset Value-Based Approach for Land Readjustment and Its Implementation Using Geographical Information Systems.," p. 276, 1993.
23. J. Malczewski, "GIS-based multicriteria decision analysis: a survey of the literature," *International Journal of Geographical Information Science*, vol. 20, no. 7, pp. 703–726, Aug. 2006, doi: 10.1080/13658810600661508.
24. M. Li, Z. Bao, T. Sellis, S. Yan, and R. Zhang, "HomeSeeker: A visual analytics system of real estate data," *Journal of Visual Languages & Computing*, vol. 45, pp. 1–16, Apr. 2018, doi: 10.1016/j.jvlc.2018.02.001.
25. S. Singh, N. Rohilla, and A. Kumar, "Big Data Analytics in Residential Property Buying Decisions in India," vol. 21, pp. 52–64, Aug. 2021.
26. realtor, "Real Estate in a Digital Age," www.nar.realtor. Accessed: Dec. 13, 2022. [Online]. Available: <https://www.nar.realtor/research-and-statistics/research-reports/real-estate-in-a-digital-age>
27. G. Gao, Z. Bao, J. Cao, A. K. Qin, and T. Sellis, "Location-Centered House Price Prediction: A Multi-Task Learning Approach," *ACM Trans. Intell. Syst. Technol.*, vol. 13, no. 2, p. 32:1–32:25, Jan. 2022, doi: 10.1145/3501806.
28. R. A. Silva, J. M. Pires, N. Datia, M. Y. Santos, B. Martins, and F. Birra, "Visual analytics for spatiotemporal events," *Multimed Tools Appl*, vol. 78, no. 23, pp. 32805–32847, Dec. 2019, doi: 10.1007/s11042-019-08012-2.
29. Y. Zhao, "Towards innovative system development: A joint method of design thinking and systems thinking," *INCOSE International Symposium*, vol. 25, pp. 1427–1437, Oct. 2015, doi: 10.1002/j.2334-5837.2015.00140.x.

30. C. Dym, A. Agogino, O. Eris, D. Frey, and L. Leifer, "Engineering Design Thinking, Teaching, and Learning," *Journal of Engineering Education -Washington-*, vol. 94, pp. 103–120, Jan. 2005, doi: 10.1002/j.2168-9830.2005.tb00832.x.
31. S. Wang and H. Wang, "Teaching Design Thinking Through Case Analysis: Joint Analytical Process*," *Decision Sciences Journal of Innovative Education*, vol. 9, pp. 113–118, Jan. 2011, doi: 10.1111/j.1540-4609.2010.00295.x.
32. InteractionDesign, "What is Design Thinking?," The Interaction Design Foundation. Accessed: Dec. 13, 2022. [Online]. Available: <https://www.interaction-design.org/literature/topics/design-thinking>
33. O. Serrat, "Design Thinking," Mar. 2010.
34. rumah123, "Rumah123.com," Rumah123. [Online]. Available: <https://www.rumah123.com/>
35. Lamudi, "Lamudi," Rumah Dijual, Sewa Apartemen, Jual Tanah Lamudi Indonesia. [Online]. Available: <https://www.lamudi.co.id/>
36. OLX, "OLX." Accessed: Jun. 11, 2023. [Online]. Available: <https://www.olx.co.id/>
37. 99.co.id, "99.co." [Online]. Available: <https://www.99.co/id>
38. trovit, "Trovit," Sewa dan jual properti - Trovit. [Online]. Available: <https://rumah.trovit.co.id>
39. jendela360, "Jendela360: Situs Sewa Apartemen #1 di Indonesia," Jendela360. [Online]. Available: <https://jendela360.com>
40. rumahku, "Rumahku," Tentang Rumahku. [Online]. Available: <https://www.rumahku.com/about/>
41. Pinhome, "Pinhome," Jalan Menuju Rumah Idaman - Pinhome. [Online]. Available: <https://www.pinhome.id/pages/mobile-app/>
42. rightmove, "Rightmove - UK's number one property website for properties for sale and to rent." Accessed: Jun. 18, 2023. [Online]. Available: <https://www.rightmove.co.uk/>

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