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Best Practices And Applications Of Gis-Based Real Estate Databases: A Systematic Review

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Abstract:*The real estate sector plays a vital role in economic development. However, decision-making in this sector remains complex due to the multifaceted nature of property valuation, management, and marketing. While Geographic Information Systems (GIS) offer powerful tools for spatial data integration and analysis, their full potential in real estate applications remains underexplored. This study addresses the gap by systematically reviewing best practices in GIS-based real estate databases by identifying the key applications and proposing a conceptual framework for the best-practice GIS database. This study employs a systematic literature review adhered to the PRISMA framework. A narrative synthesis approach was adopted to organise the application of GIS in real estate into three thematic categories, which are the property valuation, management, and marketing. This is to answer the first research question regarding the applications of GIS-based systems in real estate domains. Next, a conceptual framework is proposed, emphasising the best practices in four criteria, viz., data integration and structure, functionality and features, technology and implementation, and data quality and maintenance. Thus, the conceptual framework addresses the second research question regarding the best practices in developing and managing GIS-based real estate databases. This study serves as a stepping stone for future research that may explore the development of real estate GIS databases as well as the adoption barriers.*
Keywords: *GIS; real estate database; best practices, systematic review*

INTRODUCTION

The real estate sector is an important part of a country's economy and society because it builds important infrastructure and helps the economy grow by creating jobs and business opportunities. Artificial intelligence and digital platforms are more common today in helping the decision-making process in this sector (PwC, 2025). Effective decision-making, planning, and management in the real estate sector increasingly rely on accurate, comprehensive, and up-to-date data. However, the decision-making process might be very complicated, considering several diverse factors, like household requirements, building amenities, site features, and so on (Rabiei-Dastjerdi et al., 2020). Such complexities affect the decision-making process for real estate stakeholders. They often rely on various sources of information, particularly with the aid of digital platforms or databases.

On the other hand, conventional real estate websites frequently lack the precise location data needed to guide spatial decision-making (Rabiei-Dastjerdi et al., 2020). With the rapid evolution in GIS technology, dealing and analysing spatial data like properties and land parcels with their attributes has become simple and efficient. Still, the extent to which GIS is adopted and its full potential in real estate applications remains underexplored. Thus, this systematic review aims to explore the best practices in developing and utilising GIS databases for application in the real estate sector.

This study contributes to three main aspects. Firstly, it provides a comprehensive review of existing scientific literature on GIS databases in the real estate sector. Second, it identifies the applications of GIS-based systems in various real estate sectors. Thirdly, it synthesises the data to explore the best practices of GIS-based real estate databases. This article is structured as follows. The first section introduces the study. The second section provides an overview of the real estate sector. This is followed by the method of this systematic review. The fourth section identifies the application of GIS-based systems in various real estate sectors. The fifth section explores the best practices of the GIS database in the real estate sector. The last section concludes the study.

OVERVIEW OF REAL ESTATE SECTOR

Real estate refers to property, buildings, and other immovable assets that are bought, sold, rented, or leased for profit generation or personal use (Thrall, 1998). This sector serves as a crucial engine of employment, investment, and GDP expansion, thus making it indispensable for a nation's socioeconomic progression (Gao et al., 2024). In Malaysia, the real estate professions are categorised into 3 types, namely valuer, property manager, and real estate agent. The property market in Malaysia has risen extensively in recent years, which can be indicated by the substantial increase in transaction volumes (Sajuri & Mansor, 2023). This development is driven by multiple factors, namely the growing need for both residential and commercial properties, financing availability, and increasing trust and professionalism of real estate agents in assisting buyers (Sajuri & Mansor, 2023). The next sub-sections describe each of the pathways in real estate.

Property Valuation

Real estate valuation is a process to determine the market value of a property (Michele et al., 2010). In other words, it is the process of determining the economic worth of a property by using various methods to arrive at an estimate of its market value

(Ewa & Raczka, 2011; Wyatt, 2010). Property valuations are conducted for a variety of reasons, including property transfer, purchase and sale, estate settlement, refurbishment, investment, and financing (Yiorkas & Dimopoulos, 2017). Michele et al. (2010) perceived valuation as a complex process involving factors that are both intrinsic to the land and external, including social, economic and environmental conditions. Hence, the valuation process is crucial for many stakeholders, including property owners, investors, banks, and tax authorities.

Property Management

Property management involves overseeing the operation, control, and maintenance of real estate (Michele et al., 2010). According to Wyatt (2010), it is a broad field that includes various responsibilities ranging from managing individual properties to entire portfolios. In simpler terms, effective property management involves finding the best possible site and satisfying customer needs (Mwangi & Kuria, 2011). In summary, property management encompasses the oversight and administration of properties, including tasks such as maintenance, tenant management, and financial record-keeping, with the overarching aim to maintain the value of the property.

Real Estate Marketing

Real estate marketing encompasses several strategies and techniques to promote properties and engage with prospective buyers or renters (Michele et al., 2010; Mwangi & Kuria, 2011). Traditionally, real estate marketing that heavily relied on methods such as distributed paper advertisements will face limitations in the digital age (Li, 2021). This is because the real estate sector has been affected by the digital marketing era, as most of buyers use the internet as the main source for property search (Sajuri & Mansor, 2023). According to Pomortseva et al. (2024), digital services and online platforms serve a more global audience and can provide a more comprehensive range of information. In short, effective real estate marketing requires a combination of traditional and modern techniques that focus on providing detailed and accurate information.

The need for a GIS real estate database

A real estate database encompasses any information that relates to a particular property including geolocation, demographic data, and socioeconomic data (Thrall, 1998). Geographic Information System (GIS) is a key technology for real estate database development and management because it provides a powerful platform for the integration and analysis of spatial data (Mwangi & Kuria, 2011; Yiorkas & Dimopoulos, 2017). The use of GIS-based real estate databases has the potential to improve the real estate sector and its processes in many ways. One of its major benefits is that the use of GIS technology allows various data sources to be integrated into a single spatial database, hence dramatically increasing the efficiency. The availability of GIS-based databases has significantly increased, presenting a cheaper and more appropriate alternative for real estate professionals (Yiorkas & Dimopoulos, 2017). To put it simply, the undeniably spatial character of the real estate industry makes GIS a must-have tool in this domain.

For the valuation process, GIS-based real estate databases are extremely useful in such valuation processes by providing geographical information like proximity to desired facilities, transport infrastructure, environmental features, etc. It was demonstrated that GIS-based real estate databases can facilitate the valuation process, enhancing its effectiveness and efficiency (Yang & Bai, 2014). For instance, Yiorkas and Dimopoulos (2017) highlighted the usage of GIS databases as fundamental for mass property valuation and appraisal. Moreover, integrated databases that combine real estate data, spatial data, comparable transaction data, and valuation data will provide the most professional data support for valuation (Yu et al., 2014).In property management, the information related to various types of data for the properties is maintained using GIS databases (Budarova et al., 2018). Property management relies on GIS, because of location and the foundation of real estate. As discussed by Mwangi and Kuria (2011), GIS aids in management and assists in matching properties with client needs through the analysis of location-based data of properties (i.e proximity to major roads, electricity and clean water).

Real estate marketing is moving toward more transparent and informative approaches (Rabiei-Dastjerdi et al., 2020). With the technology of GIS being incorporated into real estate marketing, analysis and presentation of spatial data allow agents to better reach and respond to potential buyers (Fang et al., 2009). Also, with the help of web facilities, GIS can offer customers the exact location of properties and information about the vicinity to enhance the online property viewing experience (Mwangi & Kuria, 2011).

METHODOLOGY

This study adopts the PRISMA framework by Moher et al. (2009) to conduct the systematic literature review. Figure 1 outlines the PRISMA flowchart of the selection process for the included studies. Notably, this study also aligns to Kitchenham (2004) guidelines of review phases protocol (Figure 2). The details of the selection process and review protocol are explained below:

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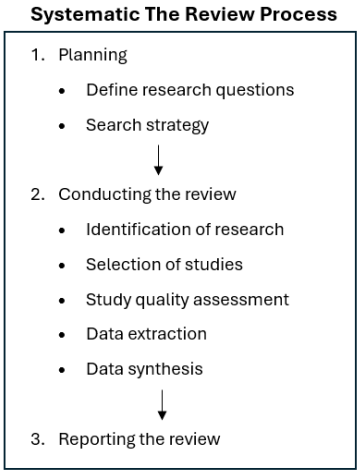

Figure 2: Guidelines of review phases protocol

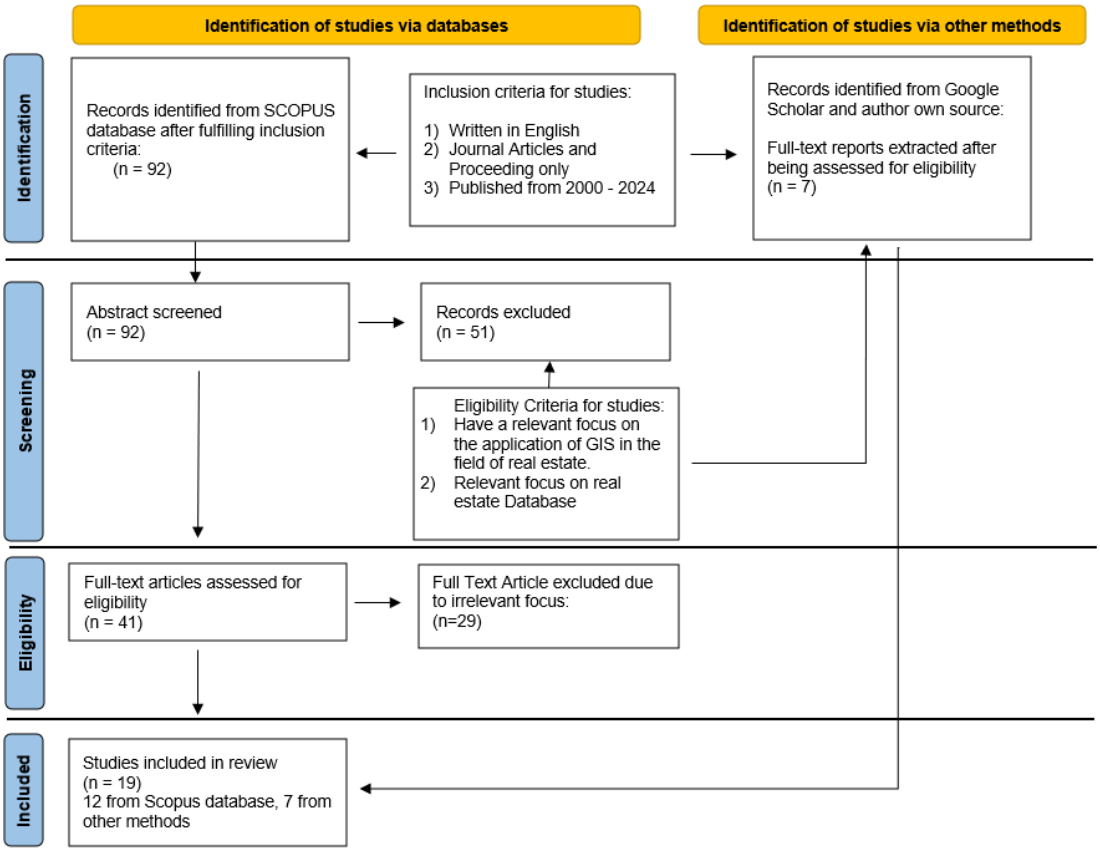

Figure 3: PRISMA flowchart

Research Questions

The research questions that the study will address are as follows:

RQ 1: What are the applications of GIS-based systems in various real estate sectors?

RQ 2: What are the best practices in developing and managing GIS-based real estate databases?

Search Strategy

A systematic search of academic journals and conference proceedings was conducted using Scopus databases. The keywords used in searching the studies was "GIS" And "Database" And "Real Estate" which resulted in 118 studies before any filtering.

Inclusion criteria

The early 2000s marked a significant turning point in the advancement of technology with the widespread internet adoption and the advancement of computing power. Hence, this review includes the studies starting from 2000 (where GIS tools were gaining popularity) to 2024. In addition, this review limited to journal articles and conference proceedings published in English only. A total of 26 articles were excluded at this stage, which resulted in 92 articles extracted. In sum, the search query is as follows:

Your query : (TITLE-ABS-KEY(gis AND database AND "real estate") AND PUBYEAR > 1999 AND PUBYEAR < 2025 AND (LIMIT-TO (LANGUAGE,"English")) AND (LIMIT-TO (SRCTYPE,"j") OR LIMIT-TO (SRCTYPE,"p")))

Quality assessment and data extraction

For maintaining the quality of the review, the following inclusion and eligibility criteria were applied:

(1) Journal articles and conference proceeding with the proper scientific structure.
(2) Written in English.
(3) Published from 2000 to 2024.
(4) Have a relevant focus on the application of GIS in the field of real estate and real estate databases.

Out of the 92 studies, 41 studies were eligible for full-text screening, but 29 were excluded due to irrelevant focus. This process left us with 12 studies that fulfilled all the criteria. Nevertheless, this review incorporates the studies via other methods (Google Scholar and the author's own source) for a broader view of the topic. The same inclusion and eligibility criteria were applied, resulting in a total of 7 studies extracted. In sum, 19 studies were included in this review, encompassing 12 studies from the Scopus database and 7 from other methods.

Data synthesis

This study employed narrative synthesis to address the research question. Narrative synthesis is a method used in systematic reviews to combine findings from multiple studies using primarily words and text, especially for heterogeneity studies where statistical meta-analysis is inappropriate or not possible (Campbell et al., 2020; Popay et al., 2006). The following steps were undertaken to conduct a robust narrative synthesis:

Developing a preliminary synthesis of findings from the included studies. (This step organises the findings from the studies to identify patterns or themes)

Exploring relationships in the data. (This moves beyond the preliminary synthesis to explore relationships within and across the included studies)

Assessing the robustness of the synthesis (This step assesses the strength of the evidence supporting the conclusions drawn from the synthesis)

Report the result (This final step involves the reporting and compilation of the results to provide recommendations)

Applications of GIS-based Systems in Real Estate Sectors

Based on the reviews, the application of GIS database in the real estate sector can be categorised into three main sectors, viz., Property valuation and appraisal Systems, real estate management Systems and real estate marketing. Table 1 summarises the applications of GIS-based systems in the real estate sector. Such categorisation is aligned with the property valuation, property management and real estate marketing as stipulated in section 2.

Property Valuation and Appraisal Systems

Over the past decades, GIS-based systems have become a key tool in property valuations and appraisals. As illustrated by Trofymenko et al. (2022), the creation of a GIS database for the expert monetary assessment of housing properties in Ukaraine yielded a positive impact on property valuation. The database contains useful information such as property type, land area, house area, price per square meter, distance to key centers, and year built. This would enable a more accurate and automatable property assessment. Likewise, Yiorkas and Dimopoulos (2017) examined the role of GIS in estimating property prices and mass valuation approaches in the Nicosia District, Cyprus. By using the Geographically Weighted Regression (GWR) method, their study shows that incorporating spatial attributes in valuation models leads to improved results.

Next, Nian et al. (2012) introduced a 3D GIS-based house price index system in Shenzhen, China. This system performs mass appraisal as well as generation of new and second-hand house price indexes by using the transaction data and 3D simulation data. Subsequently, Yu et al. (2014) proposed a 3D GIS valuation system to enhance the valuation process. The authors conclude 3D GIS framework would greatly enhance the current sales comparison approach in valuation in terms of data availability, spatial analysis and efficiency. Also, by using a comparative approach, Ewa and Raczka (2011) highlighted the role and application of real estate database systems to address the difficulties faced by property valuers in terms of large amounts of incomplete and uncertain data at every stage of the valuation procedure. This is why a real estate database is very helpful when it comes to dealing with large amounts of data.

In terms of web-based GIS platform, Michele et al. (2010) and Ludiema et al. (2018) stressed the importance of web-based GIS in the implementation of mass valuation. Michele et al. (2010) proposed a computational environment that integrates web technologies to support decision-making processes in real estate, focusing on data management and intelligent spatial decision analysis. By using open-source software, Ludiema et al. (2018) developed a web-based GIS for mass land valuation in Westlands Constituency, Nairobi County. This system helps to optimise property valuation and maximise taxation efficiency.

The review proved that GIS-based systems are a powerful tool for property valuation and appraisal. With detailed property attributes, spatial data, and analytic techniques, automated valuations have greatly improved both efficiency and accuracy. The valuation process can be further improved with applications of 3D GIS and Web-based GIS platforms through spatial analysis.

Real Estate Management Systems

Real estate management also benefits greatly from GIS techonology. For instance, Luo et al. (2022) developed a GIS-based public housing management system for colleges and universities. The system comes in handy to manage public housing in colleges and universities, especially with the help of additional features in managing real estate, generating unit statistics, and managing rental data.

As WU (2012) and Li (2021) indicated, leveraging a combination of multi-type and multi-temporal data is likely to be the key to effectively managing data in real estate surveying and transaction management. According to Wu (2012), the designed database system can manage multi-type and multi-temporal real estate surveying data effectively. On the other hand, Li (2021) introduced a real estate information system using GIS technologies and big data to effectively manage real estate transactions. Similarly, Zaihua and Fengquan (2013) utilised GIS for urban property management in China. This system supports various urban housing management functions, including GIS information on housing property, transactions, and maintenance.

Apart from that, GIS-based systems can be used to manage agricultural land. In this regard, Hashim et al. (2022) developed a geospatial agricultural land database by combining different land and tenant data types. The database offers spatial querying, search, and statistic computation functions to allow users to extract information about land use, tenant names, etc. Also, the use of GIS-based systems in urban transport infrastructure and cadastral activities may enhance urban transport systems by improving their efficiency and safety (Budarova et al., 2018).

The review highlights that GIS-based systems have become essential tools for real estate management. The integration of GIS open spaces for spatial analysis for better management of the real estate. These applications showcase the transformative power of GIS technologies.

Real Estate Marketing

GIS-based systems also have positive impacts on real estate marketing, particularly in improving information access, visualisation, and user interaction. As stated by Fang et al. (2009), integrating Google Maps to visualize spatial data aids users to find properties and understanding the surrounding geography. Additionally, using facade photos, indoor panoramas, and detailed property information increases user interaction (Hwang, 2008).

Table 1: Applications of GIS in real estate sector

Property Valuation and Appraisal Systems		
Reference	Application	Key Features
(Trofymenko et al., 2022)	GIS database for expert monetary valuation of residential buildings.	Allows for the visualisation of property values. Generate cartographic materials that show the distribution of property values.
(Yiorkas & Dimopoulos, 2017)	Real estate price prediction and mass valuation.	Spatial attributes are determined by employing GIS by using a multi-criteria analysis. Incorporate Ordinary Least Squares (OLS) Regression method to analyse price prediction model.
(Nian et al., 2012)	Creation of a system for calculating house price indexes.	Integrates real estate attribute data, spatial data, and 3D simulation models. Creation of new and second-hand house price indexes.
(Yu et al., 2014)	3D GIS-based Single Property Valuation system.	3D GIS Valuation Model to analyse the impact of various factors on property value. Direct Comparable Sales Selection Model: which analyses the sales record based on the subject property's location.
(Ewa & Raczka, 2011)	Presents a system for property valuation using comparative approaches.	Contains a real estate database, a valuation survey database, and an analytical part that uses valuation algorithms. Incorporates the Average Price Correction Method and Pairwise Comparison Method for the comparative approaches.
(Michele et al., 2010)	A system designed to support decision-making in real estate, identifying outliers and anomalies in property valuations.	This web-based system is accessible through a web browser, allowing users to access the platform and tools from anywhere. Uses Google Maps and Google Earth APIs for interactive mapping and data visualization
(Ludiema et al., 2018)	Web-Based Geographic Information System for Mass Land Valuation	Web-Based GIS Platform. Made up of several sub-systems, including GIS property mapping, GIS valuation block mapping, mass valuation roll system, automated GIS-based revenue management, payment status and an automated sales data management system.
Real Estate Management Systems		
Reference	Application	Key Features
(Luo et al., 2022)	Public housing management information system for colleges and universities	Composed of four subsystems: real estate graphic integration, public housing basic information management, public housing business management, and data query and statistical analysis. Establishes a unified database for basic information like real estate and rooms, and allows for hierarchical information association.

(WU, 2012)	Development of a real estate surveying data management system	Able to manage real estate surveying data which is characterized by its diversity (including attribute and graphics data), multi-temporal nature, heterogeneous data models, and large volume. The system uses a logically divided database to store and manage various types of real estate surveying data, including attribute data, CAD graphics, cadastral spatial data, images, and archives.
(Li, 2021)	Real estate information systems that focus on real estate transaction management.	The design of a real estate information system using technologies like GIS, big data, workflow, and data exchange. Establishment of a comprehensive database that includes GIS data, property rights information, surveying and mapping data, and on-site images
(Hashim et al., 2022)	Establishment of a geospatial database for agricultural lands owned by Islamic endowments (WAQF)	The system uses a relationship class technique to link spatial data (land locations) with multiple forms of textual data (e.g., tenant information, contract details). The system creates a spatial database of agricultural lands using GIS, including geographic coordinates for each parcel.
(Zaihua & Fengquan, 2013)	Application of GIS) to property management	manage real estate information using GIS technology which utilizes spatial data to represent and analyse properties. The system includes functionalities to input, edit, and manage real estate data.
(Budarova et al., 2018)	Application of geospatial technologies for the analysis and development of transport infrastructure and cadastral activities in urban areas.	incorporates the use of cadastral information from the Unified State Register of Real Estate (USRN). Includes spatial and temporal data obtained for various road-related objects, used for research, design, construction, operation, and management.

Real Estate Marketing

Reference	Application	Key Features
(Fang et al., 2009)	Integrated information system for real estate agencies.	The system is built using service-oriented architecture (SOA), which allows for the integration of heterogeneous systems through web services. It provides house buyers with a user-friendly platform for searching, analyzing, and comparing real estate information, as well as utilizing spatial data for property visualization and analysis.
(Mwangi & Kuria, 2011)	Implementation of a system using map-based technology to improve the efficiency and effectiveness of real estate transactions.	Users may search for properties based on various criteria, such as price, size, number of rooms, and location. Users may "walk through" an area, zoom in and out, and drag the map to explore different properties.

(Pomortseva et al., 2024)	Expert system to assist decision-making making the real estate market.	A GIS-integrated tool that uses a combination of data, AI, and decision-making algorithms. Able to streamline the decision-making process by offering visual, data-driven insights into the real estate market.
(Hwang, 2008)	Web-based real estate database that integrates GIS and mapping technologies to enhance property search.	The system supports two types of queries: traditional conditional queries (e.g., price, number of floors) and spatial queries (e.g., proximity to parks, schools, markets). The system provides detailed information about each property, including photos of the facade, interior panoramas, and virtual reality scenes.
(Samantha & Zhang, 2011)	Application of GIS in providing potential buyers with flood risk and insurance cost information.	The system uses elevation data to determine the flood risk for any property. The maps allow potential real estate consumers to quickly evaluate the flood risk for various properties
(Abdulrahman & Mishari, 2014)	Application of Fuzzy Object Relational Database Management Systems (FORDBMS) in real estate.	Allow sellers to express offers and buyers to make queries flexibly, similar to the way sales agents handle information in real life. The system allows flexible process used by sales agents to match offers and demands for more natural interaction.

The system developed by Fang et al. (2009) encompasses features such as price comparison, historical price analysis, and matching services for buyers to improve user experience and transaction rates. Also, Mwangi and Kuria (2011) implemented a GIS-based system in Kenya for users to buy, sell, or rent properties conveniently online. Users can search for parcels or houses conditionally with respect to price, size, etc. The internet provides potential buyers with a lot more information about properties, which leads to better decisions being made when searching for properties (Mwangi & Kuria, 2011). Another system developed by Abdulrahman and Mishari (2014) allows sellers to express offers imprecisely and buyers to make queries flexibly, similar to the way sales agents handle information in real life.

According to Samantha and Zhang (2011), the use of GIS to analyse real estate properties in relation to flood zones helps potential real estate consumers evaluate estimated flood risks and related flood insurance costs, thus providing them with valuable information for informed decision-making. A recent expert system by Pomortseva et al. (2024) allows GIS and artificial intelligence to work together to help stakeholders make purchasing decisions. This system aids the decision-making process for potential buyers by identifying the best-suited properties, presenting data in user-friendly ways, and utilising analytical methods to derive insights from large datasets in the form of visualizations.

Overall, the application of GIS-based systems in real estate marketing yielded promising results in enhancing the decision-making process. Spatial analysis, price comparison, historical price analysis, buyer-seller matching, etc. are the features that make the user experience simple and significantly improve transactions. Moreover, online platforms enable people to rent, sell, or buy property online with elements as conditional on price and size, creating more efficient property searches. More recently, innovations have merged GIS with artificial intelligence to better enable and support decision-making for real estate stakeholders.

Best practices of GIS database in real estate sector: A conceptual framework

A conceptual best practice model was formulated based on the synthesis analysis in the systematic reviews. A total of four thematic areas were presented, as shown in the figure below.

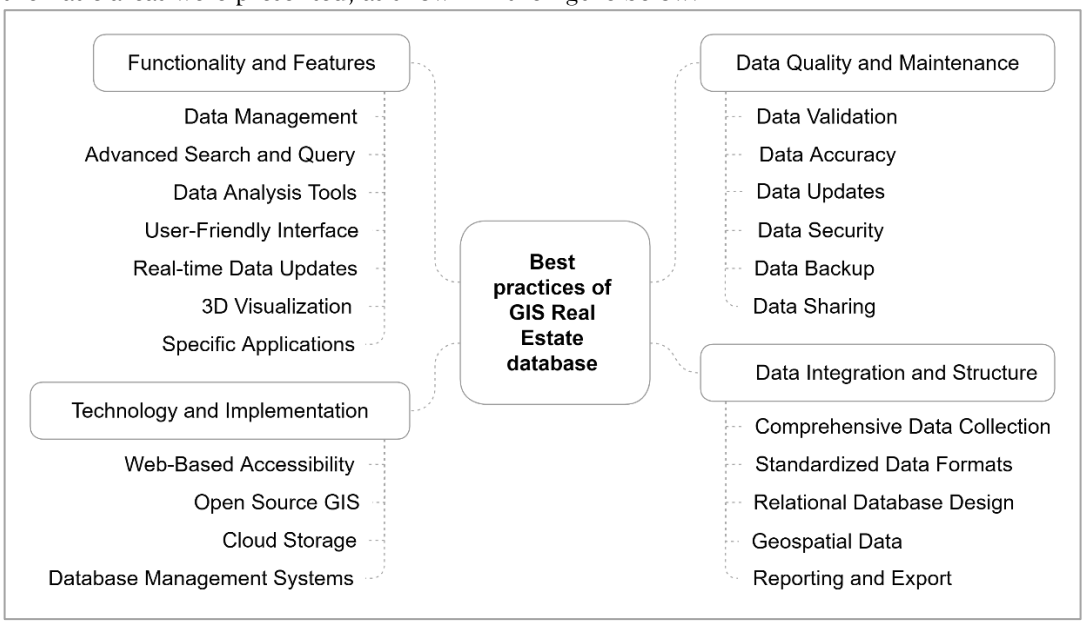

Figure 3. Conceptual model for best practices of GIS-based real estate database

Data Integration and Structure

A well-designed real estate GIS database should encompass data quality collection and standard formatted data to ensure accuracy, compatibility, and usability. For instance, a robust real estate database should be able to gather diverse data, including property attributes (e.g., land area, building size, unit details), prices, spatial data, and transaction history (Ewa & Raczka, 2011; Li, 2021; Yu et al., 2014). Integrating spatial and non-spatial data is making it possible to analyse and visualise data in comprehensive ways to aid in zoning, price prediction, and mass appraisal (Nian et al., 2012; Trofymenko et al., 2022). As stated by Fang et al. (2009), since real estate data is heterogeneous in nature, the database should adopt standard formats like XML to ensure compatibility for integration of information from multiple sources. A common standard means that everyone uses the same protocol for exchanging and conveying data across interfaces and systems.

Next, relational database design links tables with primary and foreign keys is handy when working on a real estate database. For example, a price table can be linked to a house table via a house code (Nian et al., 2012). A well-structured database may include separate modules for attributes, CAD graphics, spatial data, archives, and system maintenance (WU, 2012). Spatial

data plays an important role in location-based querying and visualisation. The combination of geospatial data with property characteristics enables more sophisticated spatial analysis and mapping (Fang et al., 2009; Mwangi & Kuria, 2011; Yu et al., 2014). It is also essential for the system to provide functions for generating reports and exporting data in different formats to allow the users to analyse and share the data (Ewa & Raczka, 2011).

Functionality and Features

Functionality and features are vital requirements in a GIS database. A real estate GIS database needs to have advanced features to assist data management. For example, the system needs to support adding, modifying and deleting real estate objects while avoiding data duplication (Ewa & Raczka, 2011). Effective data management helps keep the database precise and current. Besides, the database must allow query by price, location, property type and other feature (Hwang, 2008; Mwangi & Kuria, 2011). According to Hwang (2008), spatial queries like buffering, distance, and zone-based queries, are crucial inputs for spatial analysis.

Apart from that, the system ought to provide basic analysis functions i.e., price per meter, statistics, or the comparison of properties (Ewa & Raczka, 2011; Trofymenko et al., 2022). In mass appraisal, sophisticated data analysis approaches are also important (Nian et al., 2012; Yu et al., 2014). Next, it is recommended to have a user-friendly interface to ease users to query, view, and interact with data. The system should provide a detailed viewing of information and interactive mapping functions such as zoom, pan, and hybrid view (Ewa & Raczka, 2011; Li, 2021). Also, the information needs to be kept up to date to make sure that the data is correct and useful. As stated by Ludiema et al., (2018) and Nian et al., (2012), the system should integrate real-time data through web services and interfaces to ensure the dynamic updates.

Adding 3D graphics or visualisation can improve the user experience. 3D visualization gives a better sense of the property features and the surrounding environment. As stated by Yu et al. (2014) and Nian et al. (2012), 3D capabilities facilitate more advanced spatial analyses, such as visibility and noise analysis. Next, the database can be further improved by incorporating special applications such as mass appraisal, automated valuation, and expert systems. As an example, Pomortseva et al. (2024) demonstrated the expert systems along with GIS processes to help with assessment and making decisions by following a set of rules and controlled algorithms. Additionally, adding marketing tools like video and virtual tours to the database makes it more useful for real estate marketing and making decisions (Fang et al., 2009; Samantha & Zhang, 2011).

Technology and Implementation

When it comes to technology and implementation, a real estate GIS database must adopt modern solutions for security and accessibility. As stated by Ludiema et al. (2018) and Fang et al. (2009), there should be a web-based interface that enables users to access the system remotely. Alternatively, open-source tools such as QGIS and GeoServer offer powerful functionality that can reduce costs and make the system more affordable and accessible (Ludiema et al., 2018; Mwangi & Kuria, 2011).

Cloud-based storage and processing can further enhance its reliability and give the possibility of access from remote locations (Rabiei-Dastjerdi et al., 2020). To manage spatial data efficiently, a robust Database Management System (DBMS) should be utilised (Mwangi & Kuria, 2011). For more advanced applications, 3D GIS software can generate detailed models and support complex geospatial analysis (Yu et al., 2014). Finally, A Service-Oriented Architecture (SOA) plays a key role in integrating different functions, allowing the system to be flexible and able to obtain data from various sources (Fang et al., 2009; Luo et al., 2022).

Data Quality and Maintenance

It is crucial to perform data validation in a GIS database. Michele et al. (2010) highlight the necessity of validation processes for reducing errors and finding outliers or incorrect data. Additionally, data accuracy can be achieved by using trustworthy data sources and robust validation methods to maintain high-quality spatial and attribute data (Budarova et al., 2018). Keeping the database up to date is also crucial. This can be done though regular updates to ensure that property records and attributes reflect the latest transactions (Ludiema et al., 2018; Nian et al., 2012).

Other aspects of GIS in real estate that to consider include data security, data backups, and data sharing. As WU (2012) points out, strong security measures are essential to protect sensitive property and owner information. Backup and recovery plans are equally important to prevent data loss. Finally, the system should support seamless data sharing through standardized interfaces, enabling smooth collaboration with other departments and systems (WU, 2012).

CONCLUSION

The best practices for the development and utilisation of GIS databases for their application in the real estate sector are explored through a systematic literature review. GIS applications are categorised into three main areas in the real estate sector, namely property valuation, property management, and real estate marketing. Such categorisation is to answer the first research question of "What are the applications of GIS-based systems in various real estate sectors?". With respect to the second research question, "What are the best practices in developing and managing GIS-based real estate databases?", this study

proposes a conceptual framework to identify the best practices of GIS-based real estate databases. Based on the synthesis analysis, the framework comprises four essential criteria in designing the GIS database for application in the real estate industry. The four criteria are interconnected and work as a whole for a functioning and comprehensive database. This study serves as a stepping stone for future research that may explore the development of real estate GIS databases as well as the adoption barriers.

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