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The Use of Geospatial Information System for an Enhanced Property Valuation Process

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ABSTRACT

Property valuation is an art and science as described by professionals and in a number of case laws. Technologies like Geospatial Information System (GIS), Artificial Intelligence (AI), Building Information Management (BIM), deep or machine learning are argued to have an impact in the determination of property value. However, there is a dearth of published material that has streamlined the use of technologies, specifically the use of GIS for an enhanced property valuation process. Hence, the stance taken in this research is to set out a systematic review protocol guided by an updated PRISMA 2020 guideline for systematic reviews to search the possible use of GIS for an enhanced property valuation process. Results of the synthesised sources show four main themes of the use of GIS in the property valuation process, they are the data visualisation, mass valuation, cloud system and price prediction. Findings are significant to the development of a comprehensive integration between GIS and real estate valuation practice, and also for questionnaire development in future research for professional opinions or facts relating to this research area.

1. PROPERTY VALUATION PROCESS IN MALAYSIA

In many countries, the property sector cannot be seen as a separate economic sector as it is an integral part of the economy, including Malaysia. With good infrastructure such as transport links and urban development will boost the economic growth of the particular areas and increase property values (Ibrahim et al, 2024). A recent property market report of 2023 observed that the property market in Malaysia stayed resilient with a total transaction value worth RM196.83 billion (Ministry of Finance Malaysia, 2024).

Table 1 shows the percentage of property sub-sector contribution to transaction value in 2023 as reported in the 2023 Malaysia property market report.

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10.24191/jcrinn.v9i2.457

Table 1. Contribution to transaction value by sub-sector 2023

Property Sub-sector	Contribution
Residential	51.3%
Commercial	19.5%
Industrial	12.2%
Agricultural	9.5%
Development Land and Others	7.5%

Source: Ministry of Finance Malaysia (2024)

Property usually transacted at its market value. The determination of the market value is usually performed by valuation practitioners. In Malaysia, the professional body that monitors the valuation practitioners is the Board of Valuers, Appraisers, Estate Agents and Property Managers. According to the Board of Valuers, Appraisers, Estate Agents and Property Managers, only Registered valuers can perform valuations and provide such service for a fee as provided in the Malaysian Valuation Standards. It follows that the valuer must possess necessary qualifications, sufficient knowledge and expertise when accepting valuation instructions as provided in the Malaysian Valuation Standards. Generally, the process of valuation has been carried out manually since it was introduced and the common practice is guided by the Malaysian Valuation Standards, Sixth Edition (Board of Valuers, Appraisers, Estate Agents and Property Managers, 2024).

The valuation process commonly begins from obtaining the instruction from the client followed by the registration of the valuation case, usually in files. Afterwards, the subject property data collection is carried out to check the details from the Valuation and Property Services Department and the Department of Director General of Lands and Mines, which later an inspection of the said property shall commence. To obtain the evidence, comparable search is compulsory by searching the recent transactions of similar properties and the site analysis is done by inspecting the site, then only the estimation of property value is done based on the range calculated which leads to the market value of the land. Lastly, the respective valuer shall prepare the valuation report alongside with their opinion of value. In relation to property inspection, a manual procedure of valuation that requires physical visitation and inspections of the sites is used to measure the properties and gather other pertinent information for the purpose of determining the subject property's estimated worth. Consequently, this procedure could be difficult in particularly big locations. Eboy and Samat (2014) claimed that using manual processes in determination of property valuation could be energy exhausting, time consuming and costly for large areas and many other properties.

Technology might enhance the property valuation process as compared to the manual property inspection. Although few studies have proved that the Geographic Information System delivers more accurate and reliable data towards geographical and locational factors, property valuation firms in Malaysia are still deprived of the use of GIS in real estate valuation. This statement was supported by Ayedun (2022), where the findings from his study revealed that estate surveyors and valuers are aware of the inherent benefits of the Geographical Information System (GIS) to property valuation, but only very few of the Estate Surveying and Valuation firms make use of it in their valuation practice. Considering the need, there is a dearth published material that has streamlined the use of technology, specifically the GIS for an enhanced valuation process. Hence, this paper aims to produce academic literature on the potentialities of GIS for an enhanced property valuation process guided by a PRISMA 2020 statement: an updated reporting for systematic reviews

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2. SYSTEMATIC REVIEW PROTOCOL

Systematic review provides a more comprehensive and in-depth grasp of the research area (Abdul Salam et al., 2021). The review procedure is guided from a guideline known as the Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) 2020. The review protocol is shown in Fig 1.

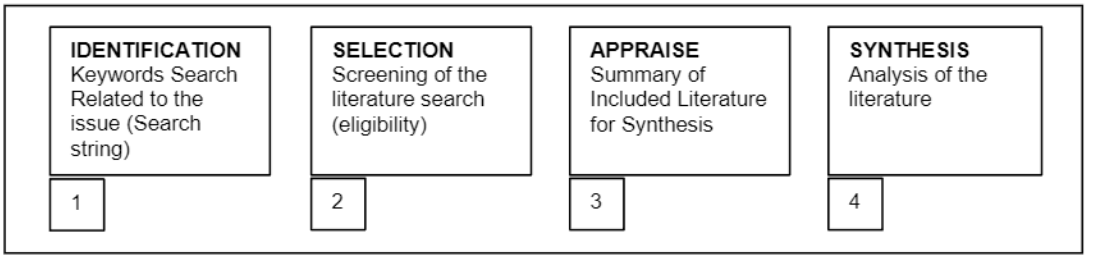

Fig. 1. Systematic review protocol

Source: Researchers' work

This guideline helps the researcher to transparently report the literature search procedures which generally involve four procedures namely identify, select, appraise and synthesis of the included publications. Furthermore, this guide helped define clear research questions that enabled systematic research. Besides that, the PRISMA 2020 statement allowed a precise search of terms relevant to the research area.

2.1 Search String and Eligibility

The first phase identified keywords used for the search process and the use of thesaurus for the keywords that were related to GIS and real estate valuation. The review was based on two renowned major journal databases; Web of Science and Scopus for screening phase. Firstly, Web of Science contains more than 30,000 journals covering approximately 260 disciplines, such as environmental studies, social sciences, architectural subjects and social issues. and sustainable development et cetera. Secondly, Scopus was the next online database used for systematic literature review. It is one of the most widespread online databases of peer-reviewed literature, with up to 23,000 journals from 5,000 publishers worldwide.

In the next phase, authors only select literature with empirical data and reviews that are peer reviewed for eligibility criteria. With regards to publication years, this research only limited the search timeline from 1980 to 2024. Although GIS was introduced in the mid-1970s, only in 1982 the first world's commercial GIS was launched (Esri Malaysia, 2024). Lastly, only publications in Malay and English language and GIS in real estate valuation are eligible for literature inclusion phase.

2.2 Inclusion and the Summary Table of the Included Literature

The remaining articles were assessed and analysed for review analysis. Efforts were concentrated on the specific studies that responded to the formulated question. The data was extracted by reading the abstracts first, then the full articles in-depth to identify appropriate themes and sub-themes. Table 2 below summarises the identified uses of technology that can be integrated in real estate valuation through various aspects which helps ease the valuation practitioner's work.

10.24191/jcrinn.v9i2.457

Table 2. Application of technology for an enhanced property valuation process

Application	Description	Authors/Year
Data Visualisation	Adjustment factors for terrain and flood risk analysis	Desalegn and Mulu (2021); Fenglin et al. (2023); Muzaffar (2017)
	Adjustment for site suitability	Santosh et al. (2018); Bowlin (2015); Beames (2018), Esri Malaysia (2023)
	Provide building information for taxation in property	Osland et al. (2022); Liu et al. (2017); Wyatt (1996)
Mass Valuation	Estimating the property values of large number of units	Eboy and Samat (2014); Esri Malaysia (2022); Local Authorities Act (1976)
Cloud system	Provide high data storage with quick accessibility	Mete and Yomralioglu (2021)
Price Prediction	Identifying amenities for price prediction analysis	Nazemi and Rafiean (2020); Hyndman and Athanasopoulos (2018); Liu & Liu (2019)

Source: Researchers' work

3. REVIEW SYNTHESIS AND DISCUSSION

The themes related to use of technology in real estate valuation were identified. First is data visualisation where the use of Geospatial Information System (GIS) in real estate valuation are divided into three uses, data visualisation for the adjustment through the terrain's slopes aspects and roughness effect, the site suitability for urban growth and to provide building information for taxable properties valuation. Next is the use of GIS for mass valuation to estimate property values of large quantities in a short time with little manpower and low cost. Then, the cloud storage in GIS that provides high performance data storage and computing capabilities and the fourth theme, the price prediction model in GIS which helps analyse the amenities of the properties around the area for price prediction.

3.1 Data Visualisation

The first theme is data visualisation. Real estate data can be displayed in maps, charts, and graphs using GIS visualisation, which makes it possible to identify important insights that would not be achievable using conventional data analysis techniques. Fenglin et al. (2023) states that geospatial planning is crucial for reducing flood risks and improving disaster management. Geospatial technology provides the best decision-making method by enabling the creation of flood hazard maps and conducting flood risk analysis. For instance, Desalegn and Mulu (2021) used ArcGIS to generate a flood risk map by analysing terrain characteristics such as soil type, slope, rainfall, elevation, drainage density and land use. GIS technology processes these factors and facilitates informed decision-making for flood risk management.

In addition, GIS technology also enhances valuation works by adjusting factors related to slopes and roughness (Muzaffar, 2016). By analysing terrain factors through GIS, a more accurate assessment of property value can be achieved by considering the impact of terrain characteristics on land usability and limitations. The author examines slope aspects using GIS, which involves assessing slope direction, steepness, and their implications for sunlight exposure, drainage patterns and views. In the same way, integrating the Digital Elevation Model (DEM) and ArcGIS could also determine terrain values for slope and surface roughness, aiding in identifying terrain characteristics that influence property value.

Apart from that, GIS is also a valuable tool for real estate analysis, site selection, and property mapping (Bowlin, 2015). It aids in assessing risk, determining property value, and identifying trends (Esri Malaysia, 2023). Accurate data on land use, slope, cost, aspects, road proximity, and lineament are essential for GIS-based site suitability (Santosh et al., 2018). The weighted overlay approach and spatial proximity analysis support site analysis for real estate valuation which considers the amenities, community, and future inhabitants where it is crucial in the analysis process (Beames, 2018). Besides that, GIS also plays a

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significant role in property valuation by utilising the mapping techniques to identify building locations and characteristics (Wyatt, 1996). Some of the many aspects that the valuers will take into the calculation are geographical and neighbourhood characteristics (Lee et al., 2023). It integrates the building permit and ownership data, as well as infrastructure and hazard information, where it offers a comprehensive perspective on the building's data and enables the application in diverse areas such as urban planning, building design, construction management, and maintenance (Liu et al., 2017).

3.2 Mass Valuation

GIS helps in mass valuation on estimating the properties values in large quantities in a short amount of time with little manpower and low cost. It involves evaluating numerous properties using statistical techniques and automated valuation approaches, providing consistency and regularity in ad-valorem assessments. With the aid of GIS, a single census region can be studied in detail for population evolution (Esri Malaysia, 2023). In Malaysia, manual revaluations have been exhaustive, time-consuming, and costly due to the large areas and properties involved (Esri Malaysia, 2022). To expedite the valuation process, a property value model can be employed to value every piece of real estate in a broad area (Wei, 2022). Research by Eboy (2014) states the Ordinary Least Square (OLS) method, integrated with GIS, becomes a component of spatial statistics and aids in spatial regression, assisting local governments in reducing costs and streamlining reassessments.

3.3 Cloud Application

The cloud storage in GIS provides high performance data storage and computing capabilities which utilises the databases for geospatial data processing, enabling valuers to analyse properties for valuation purposes. Mete and Yomralioglu (2021) referred to this cloud storage in GIS applications as the new generation of cloud architecture, referred to as serverless computing. Land valuation is complex; hence GIS simplifies the land valuation, considering various influencing factors and efficiently handles big data for mass land assessments (Kulawiak, 2019). GIS-based randomised approaches enable for a quick and effective mass valuation for large areas, proving cost and time effective, as well as helps in storing these large databases all in one system (Wei, 2022; Bencardino, 2017).

3.4 Price Prediction

GIS provides an accurate predictive approach for estimating property prices by analysing spatial factors like location, amenities, and neighbourhood surroundings (Nazemi, 2020). Machine learning, particularly short-term memory with modified genetic algorithms, has proven more efficient in predicting housing prices compared to traditional methods (Liu & Liu, 2019; Hyndman & Athanasopoulos, 2018). Descriptive maps make price changes more objective and visible over time, aiding in practical urban housing initiatives (Liu & Liu, 2019).

4. CONCLUSION AND RECOMMENDATION

The stance taken of the paper is to set out a systematic review approach guided by a PRISMA 2020 method. This systematic review has highlighted the use of Geographic Information System (GIS) in property valuation process; where it aids in analysing spatial factors to estimate the property values to enhance the transparency and critically assess the rigour of review methods in GIS applications. Based on the systematic reviews performed, authors have identified four main uses related to the use of GIS in real estate valuation namely for its data visualisation for terrain adjustments and flood risk assessments, mass valuation in large areas, price prediction model for a certain area and cloud storage for huge databases.

Consequently, from the review, it is evident that GIS's capabilities play a crucial role in supporting decision-making and understanding complex spatial relationships in the property valuation process. The findings are significant for valuation practitioners to identify and apply the possible use of technology for

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an enhanced property valuation process. Understanding the possible uses of GIS for an enhanced property valuation process could expedite the valuation process and guarantee the valuation accuracy of property as articulated by previous recent studies (Mete et al., 2022; Esri Malaysia, 2023). Considering the four main themes of the possible GIS applications in the valuation process, collecting spatial data of the subject property and comparable properties could be improved in property inspection for an enhanced property valuation process. Similar advantages are also supported by Mete and Yomralioglu (2021). In addition, by integrating technology like machine learning in property valuation will provide excellent location precision which could enhance the property valuation (Lee et al., 2023).

Despite the above contribution of this review, there are some limitations. Therefore a few recommendations for future research could improve the outcomes of this research. First and foremost, other journal databases like Education Research Abstracts Online (ERA) or other open databases could provide different literature search in publication selection and improve the eligibility phase in literature inclusion. Next, other research methods and analyses, such as a quantitative approach, could be adopted which could provide different outcomes to the research and the research significance. Hence for future study, a qualitative study is needed on the use of GIS in real estate valuation where it provides a more nuanced comprehension of the factors that influence the incorporation of GIS in real estate valuation. More explicit and detailed reporting of analysis methods for qualitative reviews can result in an improved transparency and increased ability to assess the rigour of the review method critically.

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6. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts.

7. AUTHORS' CONTRIBUTIONS

Mohamad Haizam Mohamed Saraf: Conceptualisation, supervision, methodology, visualisation, validation and writing-review and editing; **Nur Izzati Ridzuan**: Conceptualisation, investigation, formal analysis and writing-original draft; **Mohd Fadzli Mustaffa**: Writing- review and editing and validation.

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