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Understanding the Conceptual of Geography Information System (GIS) for Project Management in Malaysian Construction Industry

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Abstract

The construction industry in Malaysia is becoming more complex due to the current revolution of technology. To keep up with these changes, key players in the industry must upgrade their skills to align with the advancements of Industry Revolution 4.0. One potential solution is the utilization of Geographic Information Systems (GIS), which facilitate smooth project management by analyzing and storing spatial data. However, Malaysia's construction sector has been found slow to adopt digital skills due to high cost, complexity, safety concerns, and cultural factors. This research aims to provide preliminary studies on GIS, including its benefits and potential applications in construction. Additionally, it explores the barriers to the adoption of GIS technology in the Malaysian construction industry. Furthermore, this study seeks to serve as a valuable resource for future researchers interested in exploring the role of GIS in construction.

1. Introduction

The current construction revolution has led Malaysian construction projects to become more sophisticated and complex. Proper planning, scheduling and process of management the construction need to be precise to optimise the resources, time as well as the cost of the project (Kumar & Reshma, 2017). For the construction industry to produce high-quality projects as outlined in the Twelfth 12th Malaysia Plan, 2021–2025, technology must be used to speed up the construction process and achieve project completion. According to reports, The Twelfth Plan is primarily focused on advancing digitalization and cutting-edge technology to help Malaysia accomplish its aspirations of being a global leader in complex and high-value products. Other than that, the implementation will also lead Malaysia to the betterment of a country in terms of sustainable growth and improve the living standard of Malaysia (Twelfth Malaysia Plan, n.d.). Thus, the Malaysian construction sector needs to upgrade and prepare with the advanced skills and knowledge aligned with the Industry Revolution (IR) 4.0. Therefore, a system known as the Geography Information System (GIS) was created to make project management easier and ensure that the project ran smoothly through to completion.

Twelfth Malaysia Plan, 2021-2025 has stated that Malaysia is becoming a development of a prosperous nation by emphasizing technology. From the beginning of planning to the completion of successful projects, Malaysian industry has a tendency to construct increasingly complicated projects, such as high-rise buildings, infrastructure, and the agriculture sector, in order to keep up with the nation's progress. The problem here is that, although a project's complexity requires advanced technology in order to be completed successfully, Malaysia's industry has been in a slow pace to adopt and change to digital competencies because of the transformation's associated costs, complexity, safety and regulatory concerns, and cultural implications (Mohamad *et al*., n.d.; Sepasgozar et. al., 2023; Twelfth Malaysia Plan, 2021-2025). Technology is not being applied from the beginning of a career and due to the lack of awareness and high cost, which are the reasons for the delayed transition to digital technology (K, *et al*., 2023; Mbunge *et al*., 2020; Olatunji, 2011). According to The State of Digital Adoption in Construction Report 2023, the slow adoption of technology may mean that the workforce lacks the necessary skills to leverage new tools and systems. Professionals may be accustomed to traditional methods, and a lack of training or upskilling opportunities can contribute to a skills gap that hampers productivity. According to Dehdasht *et al* (2021); Hamid *et al*, (2021), delay is the usual problem that appears in construction projects in Malaysia. It could lead to various effects including time, cost overruns, dispute, litigation, arbitration as well as total abandonment of a project.

2. Literature Review

2.1 Definition of GIS

A geography information system (GIS) is a system that gathers, organizes, and analyzes all of the data obtained via the use of a GIS utilizing computer technology (Akob, 2019; Liu *et al*., 2021). Saleh *et al*. (2023) stated that data stored in a GIS application can be accessed and displayed in larger, sharper visuals of maps, pictures, or graphs, making it useful for future reference. The project team will ultimately find it easier to decide on one item courtesy of the output information that is displayed in the software. Communication can be enhanced by providing clearer visuals of data and facilitate the project teams to make a decision. Any issue that developed in construction-related topics, such as designing, building, and environmental analysis, can be solved with GIS. GIS can be utilized to gather data for the survey portion, and operations will help with planning and maintenance issues. It facilitates surveying, planning, and maintenance tasks, producing 3D images and even 4D models for better visualization. By integrating databases and satellite imagery, GIS ensures accurate scheduling and quantity calculations, reducing errors and saving time. Moreover, demographic data can be gathered by using GIS as well as it can monitos the labor tasks, weather and material testing at the construction sites so that the projects completed effectively and greater quality to satisfy both clients and end-users (ZhongHua *et al*., 2020).

Table 1 *Summary of Geography Information System (GIS) definition*

No.	Authors	Year	Definition
1.	Mennecke and Crossland	1996	A computerized system that offers tools for gathering, combining, organizing, analyzing, modeling, and presenting data, all referenced to precise maps showing objects in space.
2.	Sugimoto *et al*.	2007	A digital map that gives details on the areas of different features along with information regarding the current conditions at the particular area.
3.	Akob *et al*. Liu *et al*.	2019 2021	A computer-based system that collects, organizes, and analyzes data for various purposes, including construction projects
4.	Arendt *et al*.	2019	A digital system that manages the location-based data of wider geographical context which can be integrated with sources like LiDAR, photogrammetry, CAD and standard imagery.
5.	Ali	2020	A technology that allows people to collect, organize, analyze, and visualize data related to specific locations on Earth using computers, software, and specialized personnel.
6.	Munyaka *et al*.	2023	A tool that uses technology to assist in the mapping and analysis of data consists of location information

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2.2 Components of GIS

Costantini and Thompson (2023) have found that there are five primary components which include hardware, software data, people and methods as shown in Figure 1 below.

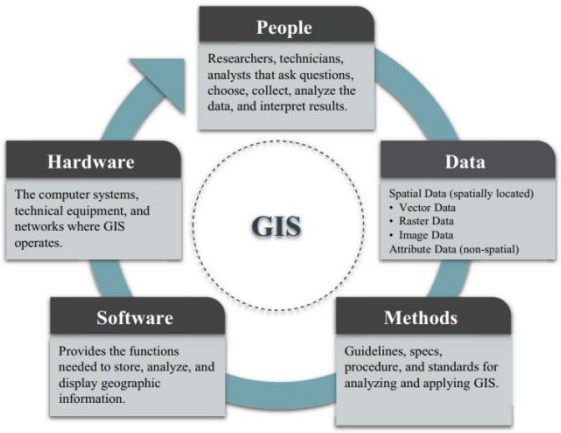

Fig. 1 *Five Components of GIS system (Costantini & Thompson, 2023)*

2.3 Benefits of GIS

(a) Improved Decisions-Making

According to Kumar and Reshma (2017), GIS integrates 2D drawings from the AutoCAD and prepares the schedules in PRIMAVERA software. The 4D generated using GIS can offer a more precise visualization of a project's progress. GIS tools provide powerful visualization capabilities, allowing construction managers to create maps, charts, and 3D models of construction sites. Effective communication with stakeholders, making it easier to convey complex information and project progress. Additionally, GIS facilitates good communication and decision-making by giving the team exposure related to the project to allow them collect information to plan for before and after the project (Akob *et al*., 2019).

(b) Time and Cost Estimation

GIS can help with project cost and schedule estimation by examining spatial trends and historical data associated with related projects. This helps to make project planning more precise. According to Saleh *et al*. (2023), GIS facilitates the digital preservation of information through automated information extraction. It results in lower costs, shorter processing times, and more accurate information. Moreover, GIS can assist in determining the project planning sequences. Using GIS, project schedule planning errors will be identified. By early detection of issues like timespace conflicts, fewer mistakes in project schedule planning prevent cost overruns (Kumar & Reshma, 2017). Additionally, ZhongHua *et al*. (2020) provided evidence in support of GIS's ability to identify conflicts between time and space in construction. Through preventing material waste at the site, GIS reduces construction costs by analyzing the model and requests for the materials needed in every element.

(c) Project Monitoring and Control

Project monitoring serves as a safety precaution in construction, focusing attention and raising consciousness regarding the potential for delays and breakdowns at any time. Kumar and Reshma (2017) state that they utilized this GIS application to track the development of a residential multistair building. As a real-time platform that provides not only current event monitoring but also the ability to take input or collected data and forecast potential outcomes, 4D GIS is becoming more and more necessary. Other industries are using GIS to monitor or coordinate the supply chain as well as to cut the cost of using logistics (Tsakiridi, 2021). Furthermore, GIS replaces the need for manual monitoring of thousands of activities, and it takes time to monitor it manually. So, GIS when combined with UAV imagery to track the progress of a 786-kilometer construction site fastly. In order to ensure that the project is finished on schedule, GIS will be utilised to capture the suits location and help with progress monitoring (Akob, *et al*., 2019). Saleh *et al*. (2023) concur that GIS can aid with progress monitoring because their research shows that it can be used to track soil erosion or degradation. Lastly, ZhongHua, *et al*. (2020) have mentioned that the progress of the construction site is visualised through the usage of GIS and BIM + VR. It makes

it easier for the labourers to oversee work in progress, identify safety hazards, and conduct quality checks to ensure the job is completed correctly.

(d) Safety and Health

GIS applications can enhance the safety of construction projects by using information based dynamic supervision methods. It helps in achieving scientific construction supervision and successfully removing safety hazards (ZhongHua, *et al*., 2020). The geography, geology, and proximity to possible hazards are a few of the factors that GIS may help with when selecting construction locations. Construction managers can reduce safety hazards by recognising and evaluating these risks early in the planning process and making well-informed decisions. For instance, GIS can track soil degradation or erosion at that specific location. Before beginning a project, it is crucial to evaluate the soil data utilising satellite technology to determine the precise soil (Saleh, *et al*., 2023)

Table 2 *Overview of summary on benefits of GIS in project management*

Benefits /Authors	Improved Decision Making	Time and Cost Estimation	Project Monitoring and Control	Safety and Health
Kumar and Reshma (2017)	✓	✓	✓	
Akob *et al*. (2019)	✓		✓	
Campbell and Masser (2020)	✓			
Saleh *et al*. (2023)		✓	✓	✓
ZhongHua, *et al*. (2020)		✓	✓	✓
Tsakiridi (2021)	✓		✓	

2.4 GIS Application in Other Industries

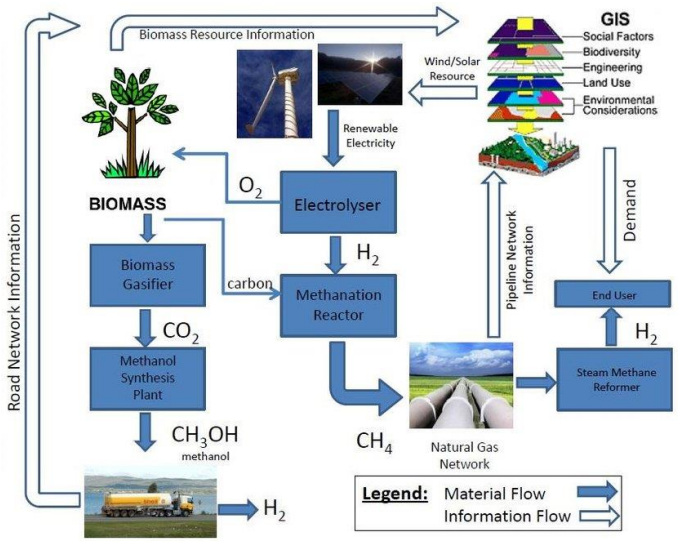

Fig. 2 *GIS assisted Biomass based Renewable Hydrogen System (Gondal, 2018)*

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(a) GIS in Biomass / Biofuel / Wood Industry

GIS helps reduce costs in logistics by optimizing warehouse locations and minimizing transportation distances, as highlighted by Tsakiridi (2021). For example, GIS helps to identify the suitable area to produce biomass such as forests, agricultural lands. This not only benefits producers and customers but also reduces greenhouse gas emissions, contributing to mitigating climate change effects. It's essential to consider the needs of all parties involved when selecting warehouse sites to ensure their satisfaction and minimize environmental impact.

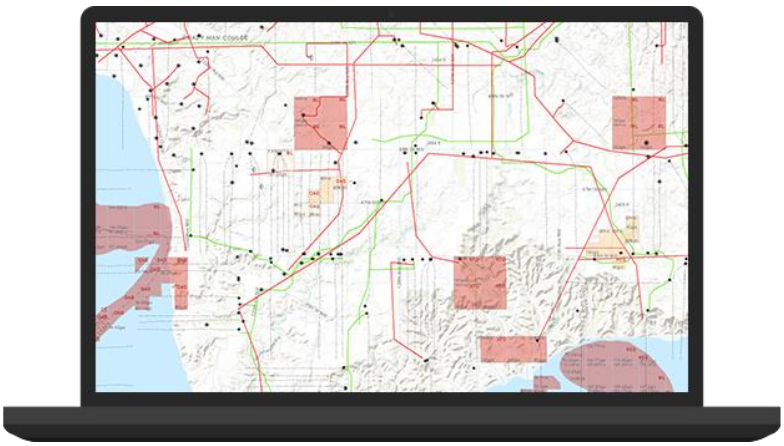

Fig. 3 *Petroleum and Pipeline Mapping & Spatial Analytics (Esri, n.d.)*

(b) *GIS in Petroleum/ Coal/ Gas*

Tsakiridi (2021) highlights GIS's role in studying various networks like ground, waterways, rail, and pipelines to create efficient transportation schedules. GIS is crucial for locating oil and gas deposits, optimizing logistics, weather forecasting, and monitoring labor status. ArcGIS Online simplifies visualization tasks, aiding in mapping oil and gas resources. It offers features like real-time data capture, analysis, and collaboration tools. Qing & Heripracoyo (2019) emphasize GIS's potential in analyzing weather changes, predicting natural phenomena, and optimizing logistics for oil and gas delivery, thus alleviating shortages in the industry.

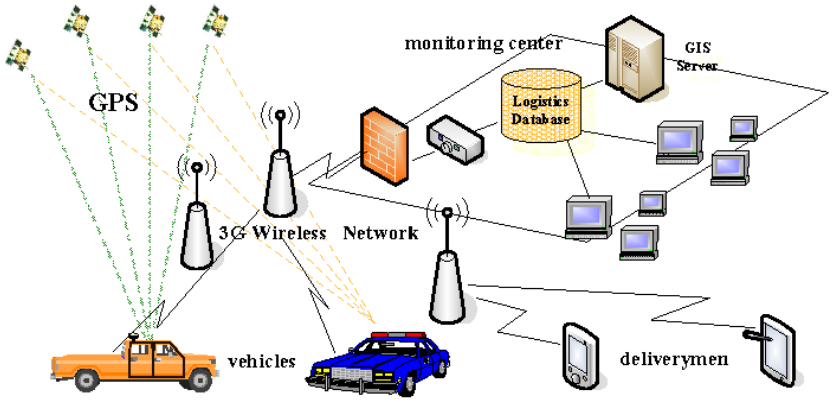

Fig. 4 *GIS in Logistics (Chen et al. 2010)*

(c) *GIS in Logistics*

According to Foster (2000); Ji-hong (2010); Tsakiridi (2021), GIS implementation in analyzing and optimizing the transportation routes using the traffic patterns, road conditions and real-time data. It can be used to determine the suitable routes to deliver the products by reducing the travel cost. Additionally, travel cost is based on the fuel consumption used to deliver the products. GIS can help the logistics to think in advance to deliver the overall delivery with suitable transportation routes. GIS also helps to analyze the market trends, and find the best location of warehouses and distribution centres.

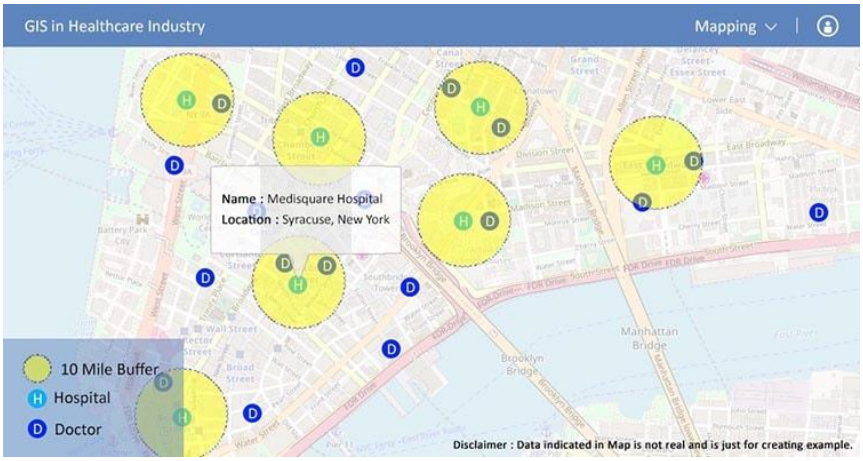

Fig. 5 *GIS in Medical for Mapping (Upadhyay, n.d.)*

(d) GIS in Medical/Healthcare

GIS benefits the healthcare sector by analyzing spatial data to improve decision-making and enhance patient health. For instance, Taskiridi (2021) notes its use in assessing earthquake-prone areas, aiding communities in preparedness. Additionally, GIS monitors disease spread by analyzing spatial patterns, facilitating epidemic control. Jebur (2021) highlights GIS's role in identifying optimal locations for healthcare facilities, ensuring accessibility during emergencies. GIS plays a crucial role in the healthcare industry by aiding in mapping, tracking, and discovering health trends and services. Mapping involves locating nearby healthcare providers that meet patients' needs, facilitating access to appropriate medical care. This includes mapping hospital locations to assist patients in finding the most suitable doctor. Tracking utilizes GIS to pinpoint the precise locations of diseases, identifying potential areas for future spread. This proactive approach enhances disease surveillance and enables timely intervention to mitigate the risk of transmission (Upadhyay, n.d.).

2.5 Construction Project Management

Ahmed (2021) and Sima (2022) mentioned that project management is like a roadmap for success in any project. It's about carefully planning, organizing, and keeping an eye on things to make sure everything stays on track. Project management can be defined as knowledge, skills, tools and techniques combined to execute according to project specifications. The project management is hard to achieve if these golden triangles are not fulfilled as shown in Figure 2 below.

Fig. 2 *Project Management Golden Triangle (Ahmed, 2021)*

Project lifecycle can be defined as the explanation regarding the works that are included in each phase that must be completed to produce a product or service. This lifecycle's purpose is to assist the project manager and teams to execute the projects from the beginning to the end of the project effectively (Sima, 2022).

(a) Project Initiation

The first phase of project management is initiation, where the client decides if the project is beneficial. Tasks include problem identification, goal-setting, and forming a project team (Ahmed, 2021; Sima, 2022).

(b) Project Planning
Planning analyzes the project's structure, cost, resources, and timing. It clarifies tasks, deliverables, and team roles, fostering good communication (Ahmed, 2021; Mwebia & Yusuf, 2022).

(c) Project Execution
After planning, execution begins, supervising the team to implement the plan. It involves organizing the team, setting rules, and producing project output. Costs are monitored, and strategies adjusted if needed (Ahmed, 2021; Mohanty *et al*., 2011; Zwikael & Smyrk, 2019).

(d) Monitoring and Control
Monitoring starts during execution, ensuring progress aligns with the plan. It involves weekly progress checks and problem resolution to keep execution on track (Mohanty *et al*., 2011; Ahmed, 2021; Zwikael & Smyrk, 2019).

(e) Close-out and Evaluation
The final stage evaluates project success and completes remaining tasks. It includes final contracts, documentation, and project completion reports (Ahmed, 2021; Sima, 2023).

2.5.1 GIS Application in Construction Project Management

(a) Site Selection and Planning
According to Kumar and Bansal (2016), the utilization of a methodology and analysis based on Geographic Information Systems (GIS) offers a precise resolution for the selection of sites, taking into consideration factors such as the physical features of the land, existing infrastructure, and regulations. GIS has the capability to propose the optimal positioning of the building in order to ensure the safety of the construction process. It facilitates decision makers in easily identifying potential locations for project development. Consideration must be given to various criteria including the slope of the land, proximity to roads, land usage, distance from developed areas, susceptibility to landslides, and proximity to drainage systems (Mallick *et al*., 2022).

(b) Project Visualization
According to Bognot *et al*. (2018), Geographic Information Systems (GIS) offers a visual representation of construction endeavors through the creation of maps and three-dimensional models. This serves to communicate well among stakeholders involved in the project, facilitating a more comprehensive comprehension of the project's extent, arrangement, and ramifications on the surrounding environment. Furthermore, it enables the visualization of the monitoring of construction progress. The incorporation of a schedule within GIS results in a easier understanding of the project, while also aiding in the identification and resolution of any potential issues (Dhruw *et al*., 2022).

(c) Risk Assessment
Taskiridi (2021) has indicated that Geographic Information System (GIS) can be utilized to evaluate the regions with elevated susceptibility to seismic activity. It would be advantageous for all the localities within that vicinity to bolster their preparedness and develop strategic measures in the event of an earthquake occurrence. In line with the research conducted by Abdelkareem and Mansour (2023), the most recurrent natural calamity affecting human existence is the flash flood. Employing GIS-based superimposition analysis facilitates the anticipation of areas prone to flooding. The investigator has also ascertained that integrating GIS with Remote Sensing (RS) can aid in the management of flood disasters. Consequently, it becomes apparent that this GIS system contributes to mitigating the vulnerability of communities and empowers project managers to strategize for potential obstacles while enhancing the decision-making procedure (Tantanee *et al*. 2023).

(d) Construction Site Monitoring
Budiharto *et al*. (2019); Quamar *et al*. (2023) have indicated that the observation of construction sites can be facilitated by integrating unmanned aerial vehicles (UAVs) and geographic information systems (GIS). This approach is advantageous to the construction project due to its cost-effectiveness, and it enables enhanced access to geospatial data acquisition. The transition from traditional techniques to UAVs equipped with sophisticated

cameras and artificial intelligence has the potential to be economically viable and concurrently mitigate any potential delays. This amalgamation may prove advantageous to various sectors such as agriculture, urban planning, disaster management, or any other field that necessitates the use of UAVs for construction site supervision (Bognot *et al*., 2018). Consequently, it has been concluded that the integration of UAVs with GIS improves operational efficiency and precision, enhances the decision-making process, and facilitates superior real-time monitoring.

(e) Project Cost Estimation

Cost estimation will be developed once the design has been completed by an Architect or Engineer. According to Albrecht (2018), the project's cost is monitored in relation to the progress of the work and the estimated completion time. If there is a significant difference between the actual cost and the budgeted cost, the project team will investigate the reasons behind it and make necessary adjustments. The role of the GIS project manager encompasses the duty to ensure that the project team formulates cost estimates founded upon the most reliable and up-to-date information, and adjusts said estimates as additional or superior information becomes accessible. Moreover, the project manager bears the responsibility of monitoring expenses in contrast to the budget, and undertaking an examination in cases where project costs significantly deviate from the initial estimate. Subsequently, the project manager proceeds to implement appropriate corrective measures in order to guarantee that the project's performance aligns with the revised project plan.

2.6 Barriers in Implementing GIS in Malaysian Construction Industry

The building sector in Malaysia is developing technologically. But the use of technology in the building industry is lagging behind as new techniques gradually replace outdated ones. The building industry is in charge of planning, creating, and maintaining buildings, particularly in the infrastructural, healthcare, and educational sectors. Over the past three years, however, deployment of technology has been hindered, particularly by the COVID-19 lockdowns. The benefits of GIS, a technological advancement in the construction industry, have been demonstrated include enhanced decision-making, cost and time estimation, project monitoring and control, and safety and health, as previously discussed. However, there are barriers that hinder the use of technology in the Malaysian construction industry, as will be discussed below.

2.6.1 Lack of Expertise

It is inevitable that professionals in the construction sector will work using traditional methods on a regular basis. This is a result of the fact that some of them lack the proficiency to operate modern technology (Ye *et al*. 2013). Many of these professionals, who are typically older, are more comfortable with conventional methods that they've been using for a long time. Asma *et al*. (2020) claim that they lack the qualified personnel to adapt to the new technology, and that the salary required to cover it is also quite high due to the need for highly specialist individuals. It has been demonstrated that operating without such expertise can be challenging due to the majority of the technologies' complexity (Aghimien *et al*., 2022). Retraining staff to use new tech is time-consuming and may not be worth the cost (Boon, 2022; State of Digital Adoption, 2023). Tan (2020) has therefore discovered via his research that proficiency in the construction process requires a combination of knowledge, comprehension, and talent.

2.6.2 Lack of Budget/Funding

One of the reasons Malaysia refuses to utilize the GIS application is financial limitations. This is a result of the prohibitively high cost of GIS software (Ye *et al*., 2013). Asma, *et al*. (2020) came to the conclusion that most technologies require a larger financial investment in order to obtain the software necessary to simplify the construction process in contrast with employing conventional methods. For instance, businesses in Malaysia must invest in software like GIS in order to create all of the intricate projects there, particularly in the infrastructure industry. It is important to realize that not all Malaysian businesses can afford purchasing the software like big companies. The old method is more cost-effective for small businesses, although requiring a longer time to finish (Tan, 2020). Aghimien *et al*. (2022) and Boon (2022) have elucidated that numerous software investments are necessary, including workforce training to become proficient in GIS usage. Apart from the expense of training, one of the biggest obstacles to the adoption of GIS in the construction industry is the costs of regularly maintaining the technology. Contractors lack the funds to mitigate the risks associated with adopting new technologies since doing so will require a substantial ongoing expense in order to utilize them consistently going forward. It has been explained that many of them are capital costs and maintenance costs, like the pricey tools that need to be

purchased. According to State of Digital Adoption (2023), the percentage for the lack of budget to adopt new technology is about 41% and it is understandable if the workers are not familiar with the new technology as they are not fully exposed to the current technology.

2.6.3 Lack of Awareness

Asma *et al*. (2021) claim to have determined the awareness level comparison between the use of GIS and BIM. They might conclude that experts are less aware of GIS's presence in the construction industry and that BIM is more beneficial in that sector. Tan (2020) discovered that the Malaysian construction industry lacks awareness among the public and private sectors about the adoption of GIS applications. According to studies, specialists are not well-versed in the advantages of the technology they utilize. Without awareness, it is hard for professionals to adjust to the current state of technology. Because of this, professionals will continue to favor using conventional techniques and will oppose the application of technology (Aghimien, *et al*., 2022). Therefore, one of the main obstacles to the integrated GIS's adoption in Malaysia's construction industry may be a lack of knowledge about its availability and how to use it properly. It is also due to the government's lack of awareness of the available software that has developed (Ye *et al*., 2013).

2.6.4 Complexity of GIS Technology

It is indisputable, nonetheless, that any software in this field is difficult to comprehend. GIS software is mostly used for mapping by engineers and planners in this GIS technology. Since using this technology demands a high level of knowledge, it is not something that many other professions are too familiar with. The challenge of documenting 3D spatial data, visualizing it, and analyzing all the data needed for the GIS application has been noted by Asmaa *et al*. (2021). GIS is a powerful tool for construction project management, despite its complexity of usage. It can be used to build cost estimations, create layouts, and track building progress in real-time. It may infer that because digital tools in this field are complex to understand, it can be challenging to become familiar with new technology (Aghimien *et al*., 2022). For instance, one factor contributing to the complexity and stress of work in this area may be the combination of complex job tasks with the usage of robotic and automated systems (Boon, 2022).

2.6.5 Assurance of Data Security

Boon (2022) asserts that there is no guarantee for data security when using modern technologies. The most crucial item to have stored in a GIS application is data in case of emergency. So, there's no guarantee that the information will be completely safe. Since everything is easily accessible, information security and privacy are the most frequent problems in management projects (Aghimien *et al*. 2022). Researchers have demonstrated that the GIS is indisputable in its inability to guarantee data security (Stanik and Kiedrowicz, 2021). They assess the value of GIS in terms of quality, security, and risk associated with data loss or other potential harms.

Table 3 *Summary of Literature Review of Barriers in Implementing GIS Technology*

Barriers /Authors	Year	Lack of Expertise	Lack of Budget	Lack of Awareness	Complexity of GIS Technology	Assurance of Data Security
Ye *et al*.	2013	✓	✓	✓		
Tan	2020	✓	✓	✓		
Aghimien, *et al*.	2022	✓	✓	✓	✓	✓
Asma *et al*.	2021	✓	✓	✓	✓	
Boon	2022	✓	✓		✓	✓
Stanik and Kiedrowicz	2021					✓

State of Digital Adoption,	2023	✓	✓

3. Research Methodology

Research methodology, as described by Mohajan (2017), involves organizing, planning, designing, and conducting research. Its purpose is to uncover new issues while achieving research objectives and goals (Bhome *et al*., 2013). Data for the study is collected from various sources, including primary and secondary data. In this study, a mixed method approach combining quantitative and qualitative methods is suggested for the research methodology.

3.1 Research Method

In this study, a mixed method approach, comprising both quantitative and qualitative methods was used. In order to obtain objective, quantitative and qualitative methodologies are employed in research. This strategy includes construction companies in the Klang Valley as respondents. The given questionnaire contains a variety of question forms. The primary objective of this questionnaire is to elicit responses to the questions that occur during the formulation of study objectives. Next, during data analysis, the software Static Package Social Science (SPSS) is employed as a mathematical tool.

(a) Quantitative Method

Quantitative research, referred to as an empirical form of research, generates numerical data that can be precisely measured through the use of standardized measures and statistical analysis (Taherdoost, 2022). For this type of method, a questionnaire online survey will be distributed to all the construction parties involved in Malaysia. The main objective was to find out the awareness of GIS application in the Malaysia industries, the barriers of the implementation of GIS in the Malaysia industries as well as the strategies that need to be implemented to increase the usage of GIS in Malaysian construction industry.

(b) Qualitative Method

Qualitative research focuses on understanding participants' feelings and experiences through narrative-style exploration. It collects non-numerical data to gain new insights into a subject. This research approach uses semi-structured interviews, allowing flexibility for interviewees to elaborate based on their experiences or provide yes/no responses. Personal interviews, conducted one-on-one, are particularly effective for gathering detailed information comfortably, leading to more accurate data collection (Eze, 2023).

The research strategy involves using survey research to collect data efficiently and inexpensively, aiming to provide a detailed description of the populations being studied (Manjunatha, 2019). Urban planners, civil engineers, quantity surveyors registered under BQSM, and architects form the research population. Data collection methods include questionnaire surveys distributed online through platforms like social media and email, as well as semi-structured interviews with construction professionals (Mathers *et al*., 2009). The questionnaire method is cost-effective, while semi-structured interviews ensure high accuracy by allowing professionals to provide spontaneous responses based on experience (Ruslin and Alhabsyi, 2022). Statistical analysis will be conducted using SPSS, with Likert Scale Questionnaires used for data gathering. Results will be presented using tables, graphs, and pie charts, and analysis will include descriptive statistics and content analysis of interview responses.

4. Conclusion

In conclusion, GIS can be highlighted that can streamline with the project management in the industry. The adoption of GIS is still remained low despite its recent introduction in recent years. The paper offers a thorough analysis of the literature review on GIS and determine the barriers on using GIS in the construction industry in Malaysia. Cost implications, complexity of implementation, safety and regulatory concerns are the examples of the barriers that have been found in this article. Furthermore, the slow pace of adoption is because of the professional's familiarity with the traditional methods and lack of training opportunities. Therefore, the effective integration of GIS is beneficial to transform the project management practices and competitiveess of Malaysia construction industry sector.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm their contribution to the paper as follows: ***study conception and design****: Fahira Ardina binti Rashid, Roziha Che Haron;* ***data collection****: Fahira Ardina binti Rashid;* ***analysis and interpretation of results****: Fahira Ardina binti Rashid, Roziha Che Haron;* ***draft manuscript preparation****: Fahira Ardina binti Rashid. All authors reviewed the results and approved the final version of the manuscript.*

References

Abdelkareem, M. & Mansour, A. M. (2023). "Risk assessment and management of vulnerable areas to flash food hazards in arid regions using remote sensing and GIS-based knowledge-driven techniques". Nat Hazards 117, 2269–2295 (2023). https://doi.org/10.1007/s11069-023-05942-x

Aghimien, D., Ngcobo, N., Aigbavboa, Dixit, S. (2022). Barriers to Digital Technology Deployment in Value Management Practice. MDPI 2(6), 731. https://doi.org/10.3390/buildings12060731

Ahmed, Z. (2021). "GIS Project Management". International Journal of Information Engineering and Electronic Business Volume 2 (Issue 2) : Page 1-15 https://doi/org/10.21608/IJAEBS.2021.44226.1004

Akob, Z., Hipni, M.Z.A & Razak A.A.A.A. (2019). Deployment of GIS + BIM in the construction of Pan Borneo Highway Sarawak, Malaysia. Materials Science and Engineering 512 https://doi.org/10.1088/1757-899X/512/1/012037

Albrecht, J. (2018). "GIS Project Management". https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1501&context=hc_pubs

Ali, M. E. (2020). "Geographic Information System (GIS): Definition, Development, Applications & Components". https://www.researchgate.net/publication/340182760_Geographic_Information_System_GIS_Definition_Development_Applications_Components

Arendt, A. Illikchyan, A., Warcup, R. (2019). "An exploratory study of awareness and perceived relevance of GIS among general contractors in the USA"https://www.itcon.org/paper/2019/18

Bhome, S., Chandwani, V., Iyer, S. (2013). "Research Methodology". https://www.drnishikantjha.com/papersCollection/Research%20Methodology%20.pdf

Bognot, J., Candido, C. Blanco, A. (2018). "Building Construction Progress Monitoring Using Unmanned Aerial System (Uas), Low-Cost Photogrammetry, And Geographic Information System (Gis)" http://dx.doi.org/10.5194/isprs-annals-IV-2-41-2018

Boon, J. (2022). (PDF). "Barriers to the adoption of new safety technologies in construction: a developing country context." ResearchGate https://doi.org/10.3846/jcem.2022.16014

Budiharto, W. Chowanda, A., Gunawan, A. A. S. *et al*. (2019)."A Review and Progress of Research on Autonomous Drone in Agriculture, Delivering Items and Geographical Information Systems (GIS)" 2019 2nd World Symposium on Communication Engineering (WSCE) http://dx.doi.org/10.1109/WSCE49000.2019.9041004

Chen, Z., Zhu, L., & Teng, Y. (2010). Application of GIS/GPS Technology in Mobile Logistics Public Information Platform. 2010 *International Conference on Logistics Engineering and Intelligent Transportation Systems, 1-4.* https://doi.org/10.1109/LEITS.2010.5664964

Costantini, R. & Thompson, C. (2023). "Leveraging Geographic Information in Organization Studies: Beginning the Conversation". 26(1):35-5110.37725/mgmt.2023.7664

Dhruw, P., Turkey, P, Kanwar, S. *et al*. (2022). "Understanding GIS in visualization and evaluation of construction schedule". https://ymerdigital.com/uploads/YMER210850.pdf

Eze, V. H. U. (2023). "Qualitative Research" International Digital Organization for Scientific Research. IDOSR JOURNAL OF COMPUTER AND APPLIED SCIENCES 8(1):20-35, 2023. https://www.researchgate.net/publication/367221023_Qualitative_Research

Foster, M. (2000). "Review of the use of Geographical Information Systems in the Marketing and Planning of Logistics Services". https://www.semanticscholar.org/paper/Review-of-the-use-of-Geographical-Information-in-of-Forster/20539410fa7834c9434d07c547cc666ca1ecec08

Gondal, I. A. (2018). "Infrastructure Analysis for producing hydrogen from renewable energy in Pakistan". https://www.researchgate.net/publication/329140200

Jebur, A. K. (2021). "Uses and Applications of Geographic Information Systems". Saudi Journal of Civil Engineering. 10.36348/sjce.2021.v05i02.001

Ji-hong, W. (2010). "Logistics Management Information System Research Based on GIS". Computer Knowledge and Technology. https://www.semanticscholar.org/paper/Logistics-Management-Information-System-Research-on-Ji-hong/a99427871f4dc43ec69e6802bf13736df82d2c8

Kumar, A.C. & Reshma, T. (2017). 4D Applications of GIS in Construction Management. Advances in Civil Engineering. Volume 2017, Article ID 1048540, 9 pages https://doi.org/10.1155/2017/1048540

Kumar, S., and Bansal, V. K. (2016). A GIS-based methodology for safe site selection of a building in a hilly region. Frontiers of Architectural Research, Vol. 5 No. 1, pp 39–51. https://doi.org/10.1016/j.foar.2016.01.001.

Mallick, J. Kahla, N. B., AlQadhi, S. *et al*. (2022). "GIS-Based Decision Support System for Safe and Sustainable Building Construction Site in a Mountainous Region". Sustainability-Vol. 14, Iss: 2, pp 888-888 https://doi.org/10.3390/su14020888

Manjunatha, N. (2019). "Descriptive Research". JETIR June 2019, Volume 6, Issue https://www.jetir.org/papers/JETIR1908597.pdf

Mathers, N., Fox, N., Hunn, A. (2009). "Surveys and Questionnaires". https://www.rds-yh.nihr.ac.uk/wp-content/uploads/2013/05/12_Surveys_and_Questionnaires_Revision_2009.pdf

Mennecke, B. E & Crossland, M. D. (1996) "Geographic Information Systems: Applications and Research Opportunities for Information SystemsResearchers" *Proceedings of the 29th Annual Hawaii International Conference on SystemSciences* http://dx.doi.org/10.1109/HICSS.1996.493249

Mohajan, H. K. (2017). "Research Methodology" https://www.researchgate.net/publication/321964409_Research_Methodology

Mohanty, A., Satpathy, B. & Mishra, J. (2011). "Structured Approach to Project Execution, Monitoring and Control at Operational Level". Management Science And Engineering. Vol. 5, No. 1, 2011, pp. 10-18

Monitoring Using Unmanned Aerial System (Uas), Low-Cost Photogrammetry, And Geographic Information System (GIS)" http://dx.doi.org/10.5194/isprs-annals-IV-2-41-2018

Munyaka, J. B., Chenal, J., Roulet, P. T. *et al*. (2023). "Multi-Level Participatory GIS

Framework to Assess Mobility Needs and Transport Barriers in Rural Areas: A Case Study of Rural Mumias East, a Sub-County of Kakamega, Kenya" https://doi.org/10.3390/su15129344

Mwebia, K. M. & Yusuf, M. (2022). "Role of Project Management Life Cycle on Sustainability of Devolved System of Governance Projects in Kenya". International Journal of Management and Commerce Innovations ISSN 2348-7585 (Online) Vol. 10, Issue 1, pp: (149-159) https://doi.org/10.5281/zenodo.6563224

National Construction Policy 2030 https://www.kkr.gov.my/sites/default/files/2022-10/Dasar-Pembinaan-Negara-NCP2030.pdf

Petroleum & Pipeline GIS | Mapping & Spatial Analytics for Oil and Gas Industry. (n.d.). Esri https://www.esri.rw/en-rw/industries/petroleum/overview

Qing, C. H. G. & Heripracoyo, S. (2019). Oil & Gas Industry Mapping Analysis with GIS Approach: A Literature Review. 2019 7th International Conference on Cyber and IT Service Management (CITSM). 10.1109/CITSM47753.2019.8965340

Ruslin, R. & Alhabsyi, F. (2022). "Semi-structured Interview: A Methodological Reflection on the Development of a Qualitative Research Instrument in Educational Studies Ruslin" http://dx.doi.org/10.9790/7388-1201052229

Saleh, T. M., Jubeir, A. R., Al-Tememe, M. S. O. (2023). The Role of Geographic Information Systems (GIS) in Soil Surveying and Classification. IOP Conference Series: Earth and Environmental Science 10.1088/1755-1315/1158/2/022028

Sima, K. (2022). "Initiating a Project, the right way". https://www.researchgate.net/deref/https%3A%2F%2Fwww.researchgate.net%2Fprofile%2FKifle-Sima%2Fresearch?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

Sima, K. (2023). "Closing a project, the right way" https://www.researchgate.net/deref/https%3A%2F%2Fwww.researchgate.net%2Fprofile%2FKifle-Sima%2Fresearch?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

Stanik, J. & Kiedrowicz, M. (2021). " Methods, Techniques and Tools for Identifying and Valuing GIS Assets for Measuring Security, Quality and Risk". GIS Odyssey Journal. Volume 1, Number https://doi.org/10.57599/gisoj.2021.1.2.5

Sugimoto, J. D. Labrique, A. B., Salahuddin, A. *et al*. (2007) " Development and Management of a Geographic Information System for Health Research in a Developing-country Setting: A Case Study from Bangladesh." *J Health Popul Nutr. 25(4): 436–447.* https://pubmed.ncbi.nlm.nih.gov/18402187

Taherdoost, H. (2022). "Designing a Questionnaire for a Research Paper: A Comprehensive Guide to Design and Develop an Effective Questionnaire". Asian Journal of Managerial Science ISSN: 2249-6300 Vol.11 No.1, 2022, pp.8-16https://doi.org/10.51983/ajms-2022.11.1.3087

Tan, X. Y. (2020). Application of Integrated GNSS and GIS in Construction Industry in Klang Valley https://eprints.tarc.edu.my/id/eprint/15573

Tantanee, S. Long, G. Nusit, K. (2023). "Development of web-based spatial decision support system using landslide hazard mapping outcomes: an example of GIS-based hazard assessment". IOP Conference Series: Earth and Environmental Science, Volume 1151https://doi.org/10.1088/1755-1315/1151/1/012030

Tsakiridi, A. (2021). "Applications of Geographic Information Systems (GIS) in Supply Chain Management: Systematic Literature Review". Int. J Sup. Chain. Mgt. Vol. 10, No. 5.

Twelfth Malaysia Plan, 2021-2025. (n.d.). ICDM Pulse. https://pulse.icdm.com.my/wp-content/uploads/2021/09/Twelfth-Plan-Document_compressed-1.pdf

Upadhyay, A. (n.d.). *GIS in Healthcare Industry - Mapping, Tracking, Discover* -. igismap, from https://www.igismap.com/gis-in-healthcare-industry/

Ye, H., Brown, M. Harding, J. (2013). "GIS for All: Exploring the Barriers and Opportunities for Underexploited GIS Applications" https://www.researchgate.net/publication/258802030_GIS_for_All_Exploring_the_Barriers_and_Opportunities_for_Underexploited_GIS_Applications

ZhongHua H., ZhenKai W., Chao G., MingXiao W. & ShengTing L. (2020) Application of GIS and BIM Integration Technology in Construction Management. IOP Conference Series Earth and Environmental Science, 526(1) http://dx.doi.org/10.1088/1755-1315/526/1/012161

Zwikael, O. & Smyrk, J. R. (2019). "Executing a Project". Project Management (pp.259-273) 10.1007/978-3-030-03174-9_11

"The State of Digital Adoption in Construction Report 2023", Deloitte Australia. (2023 https://www.deloitte.com/au/en/services/economics/analysis/state-digital-adoption-construction-report-2023.html