Alam Cipta Int. J. Sustain. Trop. Des. Res. Pract. 19 S1 (1): 211-232 (2026)

ALAM CIPTA

Sustainable Tropical Design Research and Practice

Journal Homepage: http://alamcipta.upm.edu.my/

A GIS Web-Based Application for Water Pipeline Construction and Logistics Planning Projects

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ABSTRACT

This study focuses on creating a GIS web-based system for planning water pipeline construction projects in Kelantan, since the current system is an outdated way, poor collaboration, weak data visibility, and manual processes hinder effective construction project management. The study emphasises comprehensive planning, regulatory compliance, and ensuring operator and public safety by applying the System Development Life Cycle Guide (SDLC) approach, involving data collection, analysis of user requirements, and system testing. The system offers improved visualisation, project integration, and decision-making capabilities. It features a user-friendly interface, bookmark functionality, customisable legends, interactive attribute tables, and project summaries, enhancing the planning process. The study highlights the significance of GIS and website systems in water pipeline construction projects, emphasising their potential to improve efficiency and collaboration among stakeholders. This innovative system demonstrates the benefits of GIS technology in project management and offers valuable insights for future development and research in the country. It also potentially contributes to the field by showcasing the benefits of GIS technology in project management, especially for logistics dashboards and delivery schedules.

Keywords: Construction Planning Projects, Development Life Cycle Guide (SDLC), Geographical Information System (GIS) Web, Material Logistics, Water Pipeline.

ARTICLE INFO

Article history:
Received: 07 May 2024
Accepted: 29 August 2024
Published: July 2026

DOI: https://doi.org/10.47836/AC.19.S1.PAPER12

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INTRODUCTION

Water pipeline construction projects are indeed complex and large-scale endeavours that require meticulous planning, execution, and management to ensure successful completion. These projects involve the construction of pipelines to transport water from one location to another, often

spanning considerable distances and crossing various terrains. Due to their magnitude and complexity, water pipeline construction projects are typically divided into manageable sections known as "spreads," each handled by specialised workgroups with distinct crews. As one crew completes their tasks spread, the next crew seamlessly takes over to advance the construction process, ensuring a smooth and continuous workflow (Sivakumar et al., 2021).

Before the physical construction begins, crucial preliminary activities must occur. These activities encompass surveys, studies, and comprehensive planning, which are indispensable for laying the groundwork for the successful execution of the pipeline project. These preliminary efforts involve assessing various aspects, including societal needs, developmental requirements, environmental impacts, and safety considerations. A holistic construction plan is meticulously crafted, aligning with overarching objectives while effectively addressing the concerns of stakeholders involved in the study.

Monitoring and controlling the construction project's progress represent pivotal aspects of construction project management. It is essential for every team member, from engineers to contractors, to possess a comprehensive understanding of the project's trajectory. This understanding includes their respective positions vis-a-vis the initial plans, adherence to critical deadlines, and judicious allocation and management of financial resources. The primary responsibility of keeping all pertinent parties informed lies with the general contractor, who ensures that the architect/engineer and project owner are continuously apprised of the advancements and status of the project.

Progress monitoring in construction projects traditionally relied on manual data entry, which was time-consuming, arduous and prone to human error. As a result, there is an increasing recognition of the pressing need to embrace automation to enhance the efficacy of project progress monitoring and control in water pipeline construction projects. In the pre-contract phase of water pipeline construction projects in Kelantan, using old systems like AutoCAD drawings has been identified as a significant problem. These outdated systems cannot provide a complete view of the construction area, which hampers effective initial planning. As a result, delays, increased costs, and various issues arise during the project (Dosumu, 2018).

The main issue with these old systems is the need for a unified platform for managing data. AutoCAD drawings only offer specific views of the pipeline, making it difficult for planners to grasp the overall picture of the project. Consequently, identifying conflicts, selecting the optimal route, and considering environmental factors become challenging tasks. This deficiency in data visibility and accessibility leads to impaired decision-making and raises the likelihood of encountering complications during the construction phase (Zhao et al., 2019). Furthermore, the reliance on traditional drawing-based systems

inhibits effective collaboration among project stakeholders. With a centralised platform, sharing information and obtaining approvals becomes faster and more precise. This lack of streamlined communication among planners, contractors, engineers, and regulators causes delays and reduces overall productivity (Jawdat & Khalid, 2017).

Moreover, the limited capabilities of these old systems in integrating different data sources and performing advanced analyses pose additional hurdles. Critical information, such as topography or existing infrastructure, cannot be adequately incorporated, hampering planners from evaluating feasibility, assessing risks, or optimising resource allocation effectively (Behnam et al., 2016). To overcome these challenges, a proposed solution involves developing a web-based application using GIS technology. This application would offer a user-friendly interface for managing, visualising, and analysing data related to the construction area. Planners can accurately assess the construction site and make well-informed decisions by incorporating geospatial information, such as satellite imagery and terrain models (Azevedo et al., 2014).

The proposed GIS-based system would also foster improved collaboration among project stakeholders. By providing a centralised platform for sharing documents, real-time updates, and interactive mapping, communication, coordination, and decision-making can be significantly enhanced (Yap et al., 2021). Additionally, the application would enable advanced spatial analysis, empowering planners to evaluate environmental impacts, identify conflicts, and optimise pipeline routes based on terrain and community considerations. This enhanced analysis would lead to more efficient and sustainable project outcomes (Ahmed et al., 2018). Current studies have shown that web-GIS applications are effective for advanced water-pipeline planning, design, and decision support systems (Raj & Bansal, 2023; Alzarooni et al., 2023; Dongare et al., 2024; Saravani et al., 2024).

By addressing the limitations of old systems and proposing a comprehensive GIS-based solution, the web-based application aims to improve the efficiency and success of water pipeline construction planning projects in the state. The study delves into user requirements, designs and develops the system, tests its performance, and compares it with the previous system to showcase the significant benefits of GIS technology in simplifying pre-contract planning processes and optimising project outcomes in the water pipeline construction industry.

LITERATURE REVIEW

Water Pipeline Construction Project, Planning and Contract Documentation

According to a review of previous research on pipeline construction projects (Smith & Johnson, 2018), a pipeline construction project is a complex undertaking that involves planning, designing, constructing, and testing pipelines to transport materials such as

oil, natural gas, water, or sewage. These projects require specialised skills and expertise, including the ability to plan and design the pipeline route, excavate and prepare the ground for the pipeline, and install and test the pipeline. Safety is also a significant concern in pipeline construction projects, as these projects can involve working with hazardous materials and operating heavy machinery (Jones, 2016; Johnson, 2019).

The contractor should conduct monitoring of pipeline projects during the construction planning stage. This activity ensures that the work to be performed is performed according to the project duration specified in the contract and avoids problems with ongoing projects. Also, public impact should be considered when doing utility works on urban construction sites. During the utility handover process, the contractor should obtain information from the relevant authorities during the construction planning stage regarding the location of the utility underground at the construction site before dredging to avoid utility supply interruption issues (Department of Occupational Safety and Health [DOSH], 2017).

Planning and design work refers to developing plans and designs for a construction project, including determining the project's scope, identifying necessary resources and materials, and creating detailed drawings and specifications. According to previous research on construction project planning and design (Brown, 2017), this work involves the development of detailed plans and designs for a construction project, including identifying necessary resources and materials and creating detailed drawings and specifications. These plans and designs serve as a roadmap for the execution of the construction project. They are typically developed by architects, engineers, and other professionals with specialised expertise in the field (Johnson, 2019).

Jawdat and Khalid (2017) addressed that poor planning and management of construction projects can negatively impact project duration and completion. Dosumu (2018) also added that the lack of coordination under design, change of scope of work by clients, omission of design, insufficient project goal mistake, use of immature design and economic hardship of the owner are significant sources of variation due to design errors. Structural and architectural drawings also contain the most errors in design documentation for architectural projects. According to Dosumu et al. (2017), the cause of errors in construction documents is the lack of adequate documentation, which may be due to the insufficient experience of the designers; it can be concluded that errors in contract documents.

GIS and Web Applications for Water Pipeline Construction Project and Monitoring

GIS-based systems are computer systems that capture, store, manipulate, analyse, and display spatial or geographical data. These systems are used in various applications, including mapping, urban planning, resource management, and environmental analysis.

According to previous research on GIS systems (Jensen et al., 2018), these systems perform several vital functions, including the capture and storage of spatial data, the manipulation and analysis of this data using specialised software, and the creation of maps and other visualisations to display the data in a meaningful way. GIS systems are also often used to perform spatial analysis, such as calculating distances and areas or identifying patterns and trends in the data (Jones, 2016; Johnson, 2019).

The most important feature of a GIS-based system is its data quality. It refers to the data's accuracy, completeness, consistency, and dependability. According to Kuffer et al. (2021), data quality is essential in decision-making because it helps to avoid errors that could lead to incorrect conclusions. As a result, a GIS-based system must ensure that the data used in the system is accurate. The user interface is another important feature of a GIS-based system. The system should have an intuitive user interface, allowing users to access and manipulate data easily. According to Chen and Liu (2022), an intuitive and user-friendly interface makes the system simple to learn and use. A GIS-based system must have a user interface that allows users to access and manipulate data easily.

GIS is crucial in water pipeline construction projects, enhancing various planning, design, construction, and monitoring aspects. This section explores the application of GIS in pipeline construction and the software tools utilised for effective project monitoring. Additionally, it discusses the benefits, challenges, and emerging trends in GIS-based systems for pipeline construction projects. Based on the study on the Use of GIS in pipeline construction and maintenance. A review by Sivakumar et al. (2021) discusses the various ways GIS can be used in pipeline construction and maintenance, including planning and designing pipeline routes, managing construction activities, and monitoring pipeline integrity. Jones (2016) also successfully reduced project duration and expense while increasing project efficiency and accuracy using GIS.

GIS-based decision support for pipeline construction by Marcoulaki et al. (2012) presents a GIS-based decision support system for pipeline construction, which was developed and tested in a case study. The system was designed to assist in selecting the optimal route for a pipeline, considering various factors such as terrain, land use, and environmental constraints. Integrating GIS and BIM for improved pipeline construction management was conducted by Johnson (2019) and Zhao et al. (2019), discussing the integration of GIS and BIM, or Building Information Modelling, in managing pipeline construction projects. The authors propose a framework for using GIS and BIM together to improve the efficiency and effectiveness of construction processes.

According to Johnson (2019), despite their numerous benefits, GIS-based systems in pipeline construction projects encounter challenges and limitations that must be addressed

for successful implementation. These challenges arise from various aspects, including data integration, data quality, software complexity, and resource availability (Smith & Johnson, 2018; Li & Wang, 2021; Wang et al., 2022). However, for way forwarding, the field of GIS-based systems for pipeline construction projects continuously evolves, with several emerging trends shaping its future (Bonney et al., 2024).

These trends are driven by technological advancements and the need for more efficient and effective project management, including integrating remote sensing technologies, such as Light Detection and Ranging (LiDAR) and aerial imagery (Zhang et al., 2023), the application of advanced analytics, including machine learning and predictive modelling (Wang et al., 2023), the incorporation of real-time data feeds and Internet of Things (IoT) sensors into GIS-based systems (Chen & Liu, 2022) and the development of mobile GIS applications (Mohd Hasmizi et al., 2020; Zaini et al., 2020; Zain Rashid et al., 2019; Rahim & Rasam, 2019; Rasam et al., 2018), geovisualisation (Othman et al., 2019; Abdul Basir et al., 2018), open-source software (Perez-Padillo et al., 2021; Azewan & Abdul Rasam, 2020; Agus et al., 2018), GIS-MCDA (Renzi et al., 2025; Othman et al., 2025) and Geospatial Artificial Intelligence (GeoAI) approach (Jaafar et al., 2024).

Pipe network management involves planning, designing, and managing networks, also using remote sensing, photogrammetry, drone, or field survey methods, based on project budget and objectives (Patel & Nihalani, 2023), especially web-GIS applications for advanced water-pipeline planning, and decision support systems (Raj & Bansal, 2023; Alzarooni et al., 2023; Dongare et al., 2024; Saravani et al., 2024). Overall, pipeline construction projects can enhance efficiency, productivity, and environmental sustainability by utilizing remote sensing technologies, advanced analytics, real-time data feeds, open-source platforms, and mobile applications.

METHODOLOGY

Research Framework

This study examines the use of GIS technology in water pipeline construction projects in Lati, Mundok, and Repek of Kelantan, Malaysia. The study aims to evaluate the impact of GIS technology on projects and its effectiveness in optimising outcomes and decision-making. The System Development Life Cycle (SDLC) framework was applied in the study comprising phases involving specific tasks and activities. The SDLC is consistent and repeatable and involves creating, reviewing, refining, and approving defined work products and documents. ArcGIS, a software that integrates authoritative and public data, was utilized for comprehensive pipeline expansion activities, primarily for planning, design, and construction (ESRI, 2023). The phases were tailored to accommodate unique project aspects, as shown in Figure 1.

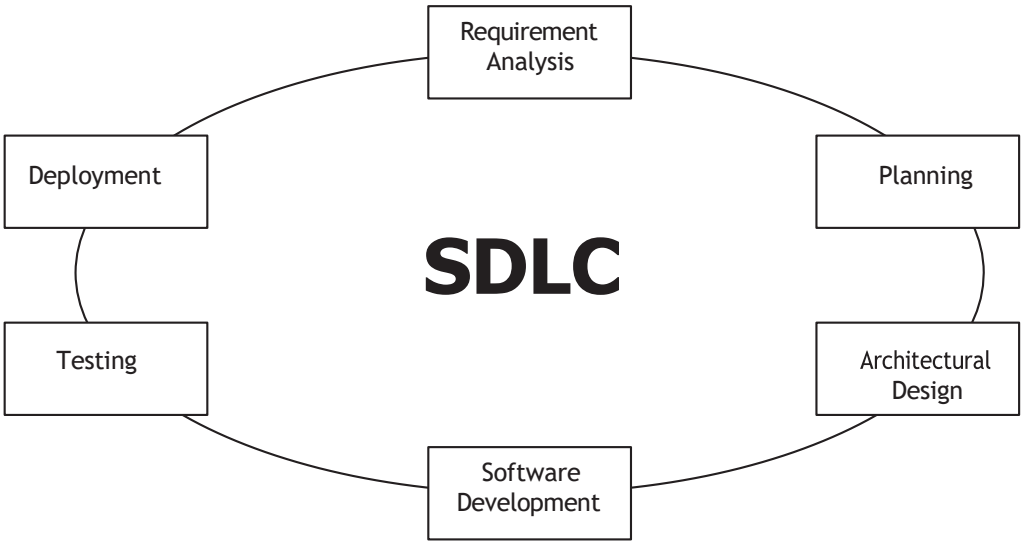

Figure 1. SDLC process for the system development (https://www.clouddefense.ai/)

They are firstly, conducting requirement analysis and planning through questionnaire distribution. This user requirement analysis aims to capture the perspectives and expectations of various stakeholders, including project planners, engineers, contractors, and regulatory authorities. By conducting interviews, surveys, and workshops, their valuable input was documented and incorporated into the design and development process of the proposed system. These interviews 23 conducted in a structured manner, ensuring that all relevant topics are covered. Open-ended questions encourage stakeholders to share their insights and provide detailed feedback on the existing challenges they face in the planning phase of water pipeline construction projects.

The questionnaire comprises three sections: A, B, and C. Section A assess the Respondent's profile, while Section B evaluates the existing system for monitoring pipeline projects. Stakeholders provide information about their occupation, experience, and familiarity with GIS. Section B measures satisfaction and opinions using a Likert scale. Section C explores the proposed system, allowing stakeholders to provide detailed responses and insights into its features and potential benefits. The intention is to gather qualitative data and understand stakeholders' expectations, needs, and suggestions for improvement.

Secondly are system design and development. Based on the gathered user requirements, the study focuses on designing and developing a GIS-based system for water pipeline construction planning. AutoCAD was used for processing DWG data and creating shapefiles

for roads, pipes, and fittings. Web Mapper was utilised to upload AutoCAD-generated shapefiles into ArcGIS Online projects, while Web AppBuilder was used for building the system, providing a flexible and customisable environment for web applications. The system design considers the unique demands of water pipeline construction planning and incorporates modules, components, and data integration requirements to meet stakeholder needs. The design process involves mapping functionalities and workflows for a seamless user experience.

Lastly, system usability testing and deployment were applied to assess the performance and usability of the GIS-based system developed for water pipeline construction projects and a comprehensive evaluation process. A sample group of stakeholders, including project planners and engineers, participated in the testing phase. Usability tests assess the system's functionality, ease of use, and effectiveness in meeting planning needs. Stakeholders were provided access to the system and guided through tasks related to their roles. They were encouraged to perform actions like visualising spatial data, tracking project progress, managing risks, collaborating with stakeholders, and generating reports.

RESULT AND DISCUSSION

Examining User Requirements for Developing a Proposed GIS Web-Based System in Water Pipeline Construction Projects

Two respondents identified themselves as clients, revealing three distinct categories: the client (AKSB), contractor, and consultant, as shown in Figure 2. Two respondents knew themselves as clients. This situation indicates the significant involvement of clients in construction projects and their valuable perspectives in understanding project planning systems. As clients play a crucial role in project initiation and decision-making, their opinions are precious in the context of planning projects. Contractors are directly involved in project implementation and execution, making their insights and experiences crucial for understanding the practical aspects of planning projects.

Their perspectives shed light on the challenges, limitations, and potential areas for improvement in the planning process. Lastly, the consultant occupation was represented by two respondents. Consultants bring expertise in project management, cost control, and quality assurance. Their input provides a holistic view of project planning systems, focusing on data quality, user interface, and analysis capabilities. Their perspectives contribute to a comprehensive understanding of planning projects from a professional consultancy standpoint.

The distribution of respondents across the three occupational categories ensures diverse perspectives in the survey results. The distribution of respondents across the three occupational categories ensures diverse perspectives in the survey results. Most

respondents (50%) have 6-10 years of construction industry experience, while the remaining respondents have either less than five years or more than ten years of experience. These findings provide an understanding of the experience level of the respondents. They could be used to analyse the perspectives and insights shared by individuals with different levels of expertise in the construction industry.

Regarding what system is being used for planning the project, the system predominantly used for planning the project among the respondents is a semi-automatic system (Figure 3). All six participants, accounting for 100% of the sample, reported using a semi-automatic system. This result indicates that most respondents rely on manual and fully digital processes for planning projects.

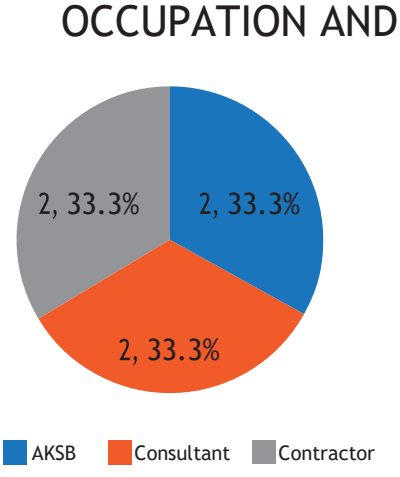

Figure 2. Occupation of the respondents

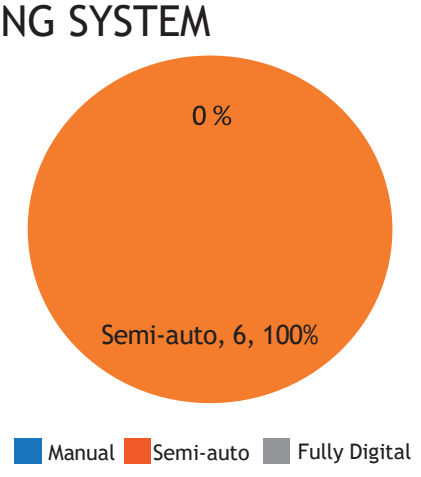

Figure 3. Existing system being used for the planning project

The questionnaire results reveal that among the six respondents, 33.3% reported using Microsoft Excel as their primary system for planning projects (Figure 4). M. Excel is a widely used spreadsheet software known for its data management and analysis capabilities, making it a popular choice in various industries, including construction. Furthermore, one Respondent (16.7%) mentioned utilising Microsoft Excel and ArcGIS in their planning project system. ArcGIS is a GIS software that enables users to analyse and visualise spatial data, providing valuable insights into the geographical aspects of the project.

Additionally, 50% of the respondents used Excel and Microsoft Project for project planning. Microsoft Project is a comprehensive project management software that facilitates planning, scheduling, and tracking of project activities. These individuals can effectively manage their projects by combining Excel's data management capabilities with

the specialised project planning features of Microsoft Projects. In summary, the results indicate that Excel is the most commonly used system for planning projects among the respondents. However, additional software tools, such as ArcGIS and Microsoft Project, also exist, reflecting the diverse needs and preferences of the respondents based on their specific project requirements.

Based on the Respondent's opinions on the existing system for planning projects, the majority of respondents, accounting for 66.7% of the total, consider the system to be moderately satisfactory. This suggests that they have a certain level of satisfaction with the system, although they also acknowledge areas where improvements can be made (Figure 5). On the other hand, 33.3% of the respondents find the system unsatisfactory. This indicates they have identified significant issues or shortcomings with the current system that hinder its effectiveness.

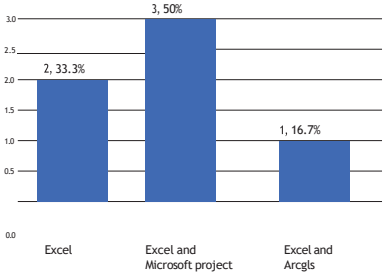

Figure 4. State the system is being used for planning project

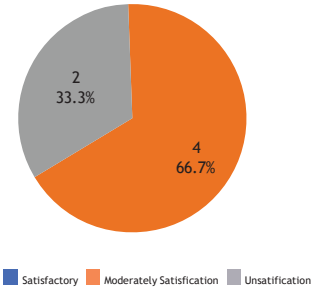

Figure 5. Satisfaction level on the existing system for planning project

Respondents who view a system as moderately satisfactory recognise positive aspects but acknowledge the need for enhancements and refinements to improve performance and address shortcomings. Those who consider the system unsatisfactory have experienced significant problems or deficiencies, highlighting areas where the system falls short in meeting expectations or fulfilling planning needs. In conclusion, while most respondents have a moderately satisfactory opinion of the existing system for planning projects, there is still room for improvement. The feedback from those who find the system unsatisfactory underscores the importance of addressing their concerns and implementing changes to enhance the system's functionality, usability, and overall satisfaction among users.

Overall, the feedback received from the respondents indicates a mixed perception of the existing systems for planning projects. While most respondents find the systems moderately satisfactory, a significant portion expressed dissatisfaction with their current systems. This suggests a recognised need for improvement to enhance the effectiveness and efficiency of project planning. In conclusion, the existing systems for planning projects rely heavily on Microsoft Excel for database management and data collection,

often supplemented with Microsoft Project for comprehensive project planning and management. The integration of ArcGIS by one Respondent highlights the importance of spatial data and mapping in the planning process. The feedback underscores the importance of continuously improving and evolving these systems to meet the evolving needs and expectations of the construction industry.

Based on the GIS criteria, the Respondents are asked to mark the criteria involved in the used system. The questionnaire results provide insights into the involvement of GIS in the systems used for planning projects (Figure 6). It can be said that the systems used for planning projects have varying levels of involvement with GIS. While data quality and user interface are prominent criteria in most systems, integration with other systems, analysis capabilities, and scalability are less prevalent. These findings highlight areas that could be further improved to enhance the effectiveness and efficiency of project planning systems, ultimately contributing to successful project outcomes as explained by Weinstock (2006).

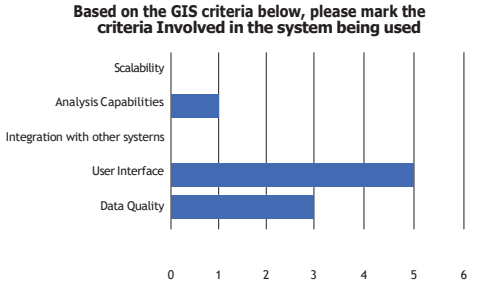

Figure 6. The GIS criteria involved in the system being used in the study area

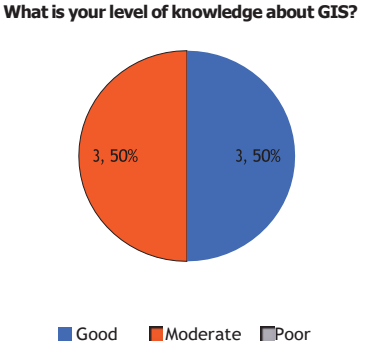

Figure 7. The level of GIS knowledge of the respondents

Regarding the potential application of GIS in the department and the staff knowledge and skill in GIS applications, all six respondents in the questionnaire have theatrically indicated that they have used/heard of GIS before this. This means they have practical or theoretical experience and familiarity with GIS technology. GIS is a software system that enables the management, analysis, and visualisation of spatial or geographical data. Practically, in terms of the respondent's knowledge and experience with GIS, 50% of the respondents reported having a good level of knowledge about GIS, while the other 50% still reported a moderate level of knowledge. No respondents indicated a poor level of knowledge (Figure 7). This indicates that all participants have at least a moderate level of understanding, suggesting a positive awareness and familiarity with GIS among the respondents. Therefore, all six respondents unanimously agree (100%) on the necessity of GIS in pipeline management. This consensus highlights GIS's significant role in optimising pipeline operations, ensuring regulatory compliance, and facilitating informed decision-making.

Designing and Developing a Tested GIS Web-Based System for Water Pipeline and Logistics Construction Projects in Kelantan

The overall interface of the Web AppBuilder in ArcGIS Online is designed to be user-friendly and easy to navigate (Figure 8). When you open the interface, you will see a dashboard displaying three main projects: Repek, Mundok, and Lati. These projects are presented as separate tiles or panels on the dashboard, allowing you to quickly identify and select the project you want to work on. The interface is organised and visually appealing, making managing your projects easy.

The system also has a Menu of Bookmarks for specific areas. Bookmarks are pre-defined geographical extents or areas of interest that can be effortlessly accessed with a single command. These bookmarks are established to represent distinct and significant areas within your projects. For instance, within the Repek project, bookmarks may be configured to highlight noteworthy landmarks or specific regions. Similarly, in the Mundok and Lati projects, tailored bookmarks would be available to emphasise their respective areas of focus.

Figure 8. Overall interface of system (Web App Builder in ArcGIS Online)

Bookmarks are pre-defined geographical extents or areas of interest that can be effortlessly accessed with a single command. These bookmarks are established to represent distinct and significant areas within your projects. For instance, within the Repek project, bookmarks may be configured to highlight noteworthy landmarks or specific regions. Similarly, in the Mundok and Lati projects, tailored bookmarks would be available to emphasise their respective areas of focus (Figure 9).

To zoom in on a specific area within a project, users can select the corresponding bookmark associated with that area. Selecting the bookmark triggers an automatic adjustment of the map view, concentrating on the predetermined extent or location it represents. This streamlined approach obviates manual panning and zooming, consequently expediting the process of reaching the desired area. This feature enhances productivity by eliminating repetitive manual adjustments and empowering users to scrutinise and analyse designated areas within their projects effortlessly.

Figure 9. Bookmark the selected study areas of the project

The Legend feature/menu in the Web AppBuilder in ArcGIS Online was also created to allow displaying and customisation of the visual representation of different elements on the map. In the context of this project, which includes Repek, Mundok, and Lati, the Legend feature can be utilised to show pipes, roads, and pipe fittings. The Legend provides a visual guide that helps viewers understand the symbols or colours used to represent these elements on the map within this project. It allows for a clear and concise representation of what each symbol or colour signifies for pipes, roads, and pipe fittings. In the Legend section, separate categories are dedicated to this project's pipes, roads, and pipe fittings. Each category includes an icon or symbol visually representing the specific element and a label or description to provide further information. This allows viewers to quickly identify and differentiate between the different data types displayed on the map within this project (Figure 10).

Figure 10. Legend of the project

The Attribute Table of the Web AppBuilder has a column showing the fitting for each pipe, such as Scour Valve, Sluice Valve, Hydrant, and S-Bend (Figure 11). By clicking on a fitting in the table, the map will automatically zoom in and show you where that fitting is on the map. This helps you see the exact location of the selected fitting compared to other features on the map. The Attribute Table makes it easy to interact with the fittings' data and quickly find their locations on the map for further analysis or reference. The Web AppBuilder of ArcGIS Online, project summary section, was also made to provide a concise overview of the Repek, Mundok, and Lati projects. It includes important details such as the pipe type, length, budget, and duration of construction. For example, the duration of construction signifies the projected timeline for completing the construction work in each project. It estimates the time required for installing and establishing the pipeline infrastructure.

Figure 11. Attribute table and time frame of the project

Testing the Performance of the Proposed GIS-Based System

This evaluation of the Web AppBuilder interface collected feedback from two respondents, identified as Respondent 1 and Respondent 2. Notably, these respondents are the same individuals who previously provided the user requirements for the Web AppBuilder interface. Their valuable insights were based on their experiences with the interface and its features. This feedback would help identify strengths and areas for improvement in the interface, ultimately enhancing the user experience and efficiency when managing geospatial projects with Web AppBuilder in ArcGIS Online.

Respondent 1 and Respondent 2 were asked to rate the user-friendliness of the Web AppBuilder interface; the evaluation delved into the Legend feature in Web AppBuilder, and the evaluation looked into the project summary section in Web AppBuilder. Both respondents praised the interface's ease of use and navigability, especially when accessing the dashboard displaying the Repek, Mundok, and Lati projects. The Respondents also unanimously lauded the project summary section as highly informative, valuing the concise presentation of critical project information that allowed for a comprehensive understanding of each project's characteristics and progress. The Respondent unanimously lauded the project summary section as highly informative, valuing the concise presentation of essential project information that gave a comprehensive understanding of each project's characteristics and progress.

In a nutshell, the evaluation of the Web AppBuilder interface through user feedback showcased intense satisfaction with its user-friendly design and visually appealing layout. The "Bookmarks" functionality, Legend customisation, Attribute Table interaction, and project summary section were recognised for their pivotal role in enhancing efficiency and data analysis capabilities. The insights gathered from this comprehensive evaluation will guide future interface enhancements and user-centric design improvements, ultimately optimise the user experience and improving the efficiency of managing geospatial projects with Web AppBuilder in ArcGIS Online.

CONCLUSION

This study underscores the significance of GIS in planning water pipeline construction projects, specifically in Kelantan. The proposed GIS web-based system provides precise spatial data representation, allowing stakeholders to visualize project areas, identify conflicts, and optimize route selection. It facilitates data integration and collaboration among project teams, enhancing communication and coordination throughout the project lifecycle. The system's user-friendly interface, bookmark functionality, customisable legends, interactive attribute tables, and project summaries contribute to a streamlined planning process. The integration of GIS and website technology can enhance data management, visualization, and analysis, leading to more efficient project

planning. This paper also assesses the effectiveness of web-based applications for water pipeline construction planning in Kelantan, emphasizing the importance of stakeholder understanding and acceptance in project execution. The study's credibility rests on its originality, data, and findings. These preliminary findings offer valuable insights for future endeavours, and further data integration, including geotechnical, environmental, and topographic data, is recommended for a comprehensive understanding of the project site and improved decision-making, especially for material logistics tracking applications.

ACKNOWLEDGEMENT

Special thanks to Vanguard Grant, MITRANS, and Air Kelantan Sdn. Bhd. (AKSB), Johan Serata Sdn. Bhd, the consultant team, and the contractor team for their unwavering support and invaluable contributions that were crucial in completing this research. Distinct thanks are also given to the construction team, whose expertise, guidance, and collaboration significantly enriched the research process. Their collective efforts have been indispensable in achieving the research goals.

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