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A SYSTEMATIC LITERATURE REVIEW ON THE ROLE OF
GEOGRAPHIC INFORMATION SYSTEMS IN
FACILITATING EXPRESS PERMITTING PROCESSES**Mohammad Daniel Shukor¹, Ahmad Afif Ahmarofi^{2*}, Zainura Idrus³¹Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM) Kedah Branch, Malaysia 2024605206@isiswa.uitm.edu.my <https://orcid.org/0009-0005-7389-488X>²Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM) Kedah Branch, Malaysia ahmadafif@uitm.edu.my <https://orcid.org/0000-0001-9270-0597>³ Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM), Shah Alam, Malaysia zainura@tmsk.uitm.edu.my <https://orcid.org/0000-0003-0457-5218>

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Abstract:

The development of Geographic Information Systems (GIS) is vital to enhance the operational efficiency of local governments while preserving public participation and upholding principles of transparency. In this context, the E10 permitting process demonstrates these purposes by integrating zoning, environment, and physical infrastructure on a common platform. Thus, the objective of this study is to evaluate GIS implementation within the E10 permitting process at Majlis Perbandaran Kulim (MPKK), Kedah state, Malaysia, through a systematic literature review (SLR). This process was guided by the PRISMA protocol. A comprehensive search across Scopus, Web of Science, and Google Scholar generated 350 initial manuscripts. Subsequently, strict inclusion and exclusion criteria were implemented for the 2020 to 2024 publication period. As a result, 60 peer-reviewed studies were selected. Consequently, three primary interconnected themes emerged, namely operational efficiency, public engagement, and ethical considerations. Subsequently, recommendations on effective GIS integration were made, including infrastructure investment, data privacy, and ethical use of GIS. Ultimately, this research contributes an actionable implementation model and targeted governance

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Keywords:

Geographic Information System (GIS), Local Authorities, Permitting Processes, Smart Governance, Systematic Literature Review



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Introduction

Sustainable development is being challenged by the ever-growing urbanization rates. In this regard, Geographic Information Systems (GIS) are able to provide centralized access to data in smart governance. Moreover, GIS has a central repository for real-time data that is accessible to other departments. By combining spatial data from various departments, municipalities can save time, improve collaboration between departments, and ensure that their decision-making process is based on the most accurate information available (Almeida, Carvalho, & Martins, 2022; Patel & Chen, 2023). This can reduce repetitive verifications, thereby improving the consistency of the workflow and operational efficiency (Zhan & Wu, 2023).

Furthermore, GIS helps regulate things such as expedited permitting processes. It can be used to expedite permitting in the context of the process of securing zoning, building, and development approvals. Loukis et al. (2022) underscored the role of GIS in expediting the permit approval process by consolidating real-time data, allowing for simultaneous verification and compliance checks. In high-growth urban areas, however, the traditional permitting processes can be a constraint on development and can have economic effects. In addition, although there has been much research on the role of GIS in smart governance, the research has largely missed the point in providing a holistic approach towards implementing GIS in local governments.

The implementation of the GIS application in this research is based on the case study of Majlis Perbandaran Kulim (MPKK) in Kedah state, Malaysia. At MPKK, GIS plays an important role in supporting the smart governance system, particularly in the express permitting processes (E10) framework. The E10 framework is a methodical approach to promote the efficiency of regulation and to make it easily accessible to the public (Mustaffa, Manaf, Halim, & Mohammed, 2023). Furthermore, the E10 framework aims to enhance service delivery and

foster trust in government activities, which can streamline service efficiency and transparency (Mustaffa et al., 2023). MPKK's GIS-enabled permitting process has integrated zoning, environmental, and physical infrastructure data on one platform, thereby providing a process for permitting that combines all these data on one platform. The above transparency measures are supportive of the concept of E10, which focuses on public trust and a user-friendly service environment, thus demonstrating the added value of GIS in the development of regulation through digital transformation.

Therefore, the aim of this study is to assess the implementation of GIS in the E10 permitting process of Majlis Perbandaran Kulim (MPKK), Kedah, Malaysia, in the context of a systematic literature review (SLR) which is guided by the PRISMA protocol. This objective helps to ensure that the current capabilities of GIS are clearly understood, with a minimum of bottlenecks, and that access to data is improved. This study then covers the challenges and ethical concerns that arise with the use of GIS for regulatory governance, including privacy concerns of data, the costs of digital infrastructure, and the lack of adequate skills and training. Last, recommendations for the integration of GIS in a manner that would conform to the concept of smart governance in the locality are emphasised.

Literature Review

The authors of Loukis et al. (2022) highlighted that GIS can assist in data-driven governance as it will help in the centralisation of information and allow for informed and swift decision-making. Patel and Chen (2023) state that GIS can turn the express permitting game by streamlining the process of having to wait for the data to be processed through multiple departments. The same view is shared by Kitchin (2022), who also states that GIS allows municipalities to normalize data and to real-time synchronize permit reviews, ensuring a consistent interpretation of regulations and reducing human error. To gain an understanding of these mechanisms, there are four theoretical foundations of GIS in smart governance as follows:

Unified Theory of Acceptance and Use of Technology (UTAUT):

The UTAUT framework by Venkatesh et al. (2003) explained why performance expectancy, effort expectancy, social influence, and facilitating conditions influence the adoption of new technology such as GIS. Moreover, Venkatesh, Thong, and Xu (2022) highlighted the dimensions of UTAUT, as these could aid in explaining the adoption of GIS for municipal governance, where real-time data access enhances workflow efficiency and interdepartmental collaboration among the various departments involved. In addition, GIS has the ability to provide real-time data access, enhancing the efficiency of workflows and interdepartmental collaboration (Loukis, Charalabidis, & Scholl, 2022). It is consistent with the UTAUT focus on reducing effort and increasing performance expectancy, with GIS making data easily accessible, interdepartmental coordination possible, and informed decision-making more effective (Rashid, Hamid, & Tan, 2024). With this fit, employees can perform data-intensive permitting tasks more efficiently and accurately to meet UTAUT objectives.

Public Value Theory

Moore (1995) suggested the concept of PVT for measuring the value that the public derives from government endeavors, for example, transparency, efficiency, and citizen consultation.

Research by Cordella and Paletti (2022) has shown that GIS can contribute to the public value given to the government by improving transparency and accountability. PVT claims that transparent and citizen-oriented governance helps to foster public trust and ensure that regulation is in line with public expectations (Cordella & Paletti, 2022; Venkatesh, Thong, & Xu, 2022). Ethical challenges are very important in GIS analysis; however, as these systems are used to a large extent with sensitive location-based information, the analysis should be treated with care (Morley, Floridi, and Taddeo, 2022). Therefore, addressing these challenges is important to make the use of GIS in the administration of smaller jurisdictions more likely to support more sustainable urban governance and effective innovation of regulations.

Dynamic Capabilities Framework

The Dynamic Capabilities Framework is a term used by Pisano (2021) which is the ability to respond to changing requirements. GIS helps enable adaptability in urban governance through a single data source that helps local governments respond quickly to zoning and development inquiries. Furthermore, Loukis et al. (2022) claim that GIS can improve the capacity of a municipality to base its decision-making on data, which is essential for urban growth management.

Institutional Theory

In Institutional Theory, DiMaggio and Powell (1983) look at the external factors that influence the decision to adopt an innovation, such as regulations and societal pressures. The adoption of GIS at MPKK is driven by the recognition of the need to modernize service delivery, satisfy public expectations, and maintain regulatory requirements. The authors Silva et al. (2023) point out that institutional pressures to modernize and produce accountability are often the reason for implementing GIS.

GIS can integrate zoning, environmental, and infrastructure data in these four theoretical foundations to boost the speed of data retrieval and decision-making. GIS-based permitting systems built on these foundations could enhance regulatory compliance by minimizing duplication of effort and accelerating approval processes, Patel and Chen (2023) wrote. Thus, the use of GIS in the field of smart governance has been growing and is assisting municipalities to become more efficient and sustainable in urban management. However, researchers have found that the literature on GIS and smart governance does not provide a complete framework that connects and explains how the four theoretical components can be incorporated into the process of effectively modernizing permitting systems in local governments.

Table 1 compares GIS applications in express permitting systems in different regions and their effects on efficiency, transparency, and public involvement.

Table 1: Comparative Applications of GIS in Express Permitting Systems

Country	GIS Application	Impact on Express Permitting	Authors
Malaysia (MPKK)	Centralized zoning and infrastructure database	Reduced approval timelines, improved cross-departmental coordination	Mustaffa et al., 2023
Singapore	Integrated spatial database for zoning	Streamlined permitting, increased regulatory compliance	Zhu, Wong, & Lee, 2022
Brazil	Automated workflows in urban planning	Enhanced operational efficiency, reduced manual processing	Silva et al., 2023
United Kingdom	Public access to infrastructure mapping	Increased transparency, improved citizen trust in regulatory processes	Kitchin, 2022

From Table 1, it can be concluded that GIS has been an important tool in the enhancement of compliance in the regulatory system, reduction of errors in urban planning, and the enhancement of resource management in Singapore (Zhu, Wong, & Lee, 2022). Likewise, in Brazil, automated GIS workflows have reduced manual operations, quickened project approvals, and improved operational efficiency (Silva et al., 2023). However, GIS in the E10 framework of MPKK in Malaysia has incorporated these 4 theoretical pillars: UTAUT, which explains why users accept technology; PVT, which explains the outputs of regulatory transparency and citizen trust; Dynamic Capabilities, which explains the adaptation of the organisation to handle real-time spatial data; and Institutional Theory, which explains the external pressures of regulatory and societal factors that drive the modernization of governance. Besides, the technical challenges, data security, and ethical concerns must be resolved to ensure the sustainable use of GIS. Based on this perspective, the following are highlighted as several important ethical questions that present relevance to GIS use in public governance:

Data Privacy:

The majority of GIS systems contain sensitive information, both spatial and demographic. The ethical issue of data privacy has come to the fore. Almeida et al. (2022) and Cordella and Paletti (2022) demonstrated the need for implementing a more stringent data governance model to ensure citizens' data is kept safe. This is also relevant to the case of public openness of the GIS dashboard, on which transparency needs to be counterbalanced with privacy protection against illegal access.

Ethics Framework:

The concept of public access to data dovetails with GIS, and ethical issues abound on issues related to its implementation. Morley et al. (2022) emphasized the use of ethical guidelines in the regulation of the sharing of GIS data, especially when it involves spatial data that may affect citizen privacy. The ideas of the PVT are supported by secure, ethical practices in relation to the use of GIS in the public governance context – ensuring transparency while maintaining private information about the individual.

In previous works, GIS improves the efficiency of operations through data centralisation and the minimisation of duplication of effort. But openness and public engagement must also be maintained in a way that is consistent with the principles of smart governance. This aspect is important in the context of GIS use in the E10 framework of the MPKK and will be explored further in the following section.

Research Methodology

Research Design

This study uses a qualitative research design and a systematic literature review (SLR) to analyse the role of GIS as a tool to help the process of an express permitting regulatory framework in the local government. The qualitative approach is designed to delve deeper into the theoretical foundations, empirical evidence, and practical implications of the integration of GIS in the governance of municipalities. The design reflects effective and transparent permitting in smart governance supported by GIS.

Data Collection

Peer-reviewed journal articles, government reports, and case studies from scholarly databases such as Scopus, Web of Science, and Google Scholar are the main sources of data for this study. This systematic approach proved to be useful in obtaining a broad and comprehensive range of studies to be considered by using keywords like “GIS in governance”, “express permitting with GIS”, “E10 regulatory practices”, and “smart city GIS integration”. Articles published between the years 2020 and 2024 were included in the study to meet the purpose of getting some fundamental and current knowledge from the research. Articles were chosen for their use of GIS for public sector governance, particularly in urban planning, permitting, and regulatory applications. Furthermore, only peer-reviewed articles and credible government publications were included to ensure the quality of the information.

The PRISMA protocol was followed in guiding this systematic literature review. Through a thorough search in Scopus, Web of Science, and Google Scholar, 350 initial manuscripts were retrieved. For the publication period 2020 - 2024, the reviewers were given strict inclusion/exclusion criteria. As such, 60 peer-reviewed studies were chosen for final thematic analysis. These studies are the basis for determining major themes, operational advantages, and issues of GIS in municipal permitting.

To bring a practical perspective, a study of MPKK was conducted on how GIS has been implemented under the E10 regulatory framework. MPKK was selected to play a leading role in developing structured regulatory practices to support transparency and efficiency. The sources used to conduct this case study were secondary sources, such as government reports, regulatory documents, and publicly available data such as MPKK's Kulim Integrated Database Spatial System (KIDS). Interviews with MPKK staff conducted during the research were also analyzed to get qualitative direction for perceived benefits and drawbacks of GIS in the work of the organization.

Data Analysis

A thematic analysis was performed to discover patterns and themes associated with GIS integration, operational efficiency, public engagement, and ethical issues. Thematic analysis was selected because it is flexible in the organisation of qualitative data, so that the study was able to broaden the picture of the complex interaction between technology, governance and citizen engagement.

A set of selected literature and the MPKK case study led to the identification of three main themes: operational efficiency, transparency and public engagement, and data governance and ethical issues. Every theme was related to the aims of the E10 framework and structured analysis of the contribution of GIS to regulatory efficiency and transparency. Comparative Analysis: The comparative analysis was applied to assess GIS use in various municipalities. This analysis aimed to give context by comparing the way MPKK is implementing its GIS-based permitting system with regions across the globe that have different levels of public engagement, regulatory practices, and governance. The comparative results are presented and discussed in terms of how MPKK's E10 approach compares with global practice and the versatility of the GIS-based regulatory models in different urban governance environments.

Based on the PRISMA protocol, Table 2 below shows the steps taken in data collection and analysis, as well as how each step supported the objectives of the study.

Table 2: Data Collection and Analysis Steps for GIS Integration Study

Stage	Description	Outcome
Systematic Literature Review	Peer-reviewed journals, reports, and case studies were reviewed based on relevance and credibility.	Identified foundational insights on GIS in governance
Initial Screening	Screened 350 records based on titles and abstracts; shortlisted 250 for full-text review	Refined the dataset to studies with direct relevance
Case Study Analysis	Reviewed MPKK's GIS implementation under E10 using secondary sources and staff interviews	Provided qualitative insights into GIS operational impact
Thematic Analysis	Identified key themes: operational efficiency, public engagement, and ethical considerations	Structured framework for data organization
Comparative Analysis	Compared GIS usage across municipalities with varied governance practices	Contextualized findings within a broader governance scope

Results and Discussion

The application of GIS technology in MPKK can resolve the typical problems of governance, including data duplication and the time it takes to complete processes, which are aligned with the principles of smart governance (Rashid, Hamid, & Tan, 2024; Silva et al., 2023). The use of GIS in the E10 regime at MPKK has been analysed based on a comprehensive thematic analysis according to the PRISMA protocol, and three main interconnected themes were found:

Public engagement, Operational efficiency, and Ethical consideration, as will be detailed below:

Operational Efficiency

Additionally, GIS technology offers huge operational efficiencies, and numerous municipalities have been attempting to implement such efficiencies in their processes to utilize resources and optimize regulatory timelines. The centralization of spatial and regulatory data via GIS reduces administrative bottlenecks and enhances workflow uniformity. According to Johnson and Lee (2023), GIS-based systems like KIDS increase efficiency by bringing together data from different departments to ensure it can be readily shared and accessed by municipal employees for data-driven decision-making. In essence, the MPKK GIS-based permitting system emphasizes the collaborative and integrated nature of data, which helps to simplify access to necessary information, minimize data duplication, and speed up permitting processes (Almeida, Carvalho, & Martins, 2022).

GIS also achieves transparency, where public dashboards enable access to current regulatory information by citizens for improved trust and accountability. Transparency in the provision of regulatory services between citizens and government agencies is a key factor in gaining citizen trust, according to the PVT theory (Cordella & Paletti, 2022). In this light, GIS supports enabling MPKK to deliver zoning updates, the status of permits, and infrastructure on an easily accessible platform. Studies conducted by Loukis et al. (2022) support the fact that open data platforms are able to facilitate the work of GIS in the sense of making the regulatory processes clearer and enhancing public engagement. The KIDS system allows citizens to quickly follow up on the status of permit applications and the zoning regulations within their area, strengthening the E10 framework's approach to open, transparent governance.

Public Engagement

The participatory potential of GIS forms one of the most integral parts of good governance in that it not only nurtures transparency but ensures that there is effective involvement of the public in the process. The GIS-powered, publicly available Web portals allow real-time queries of zoning, permitting, and infrastructure projects, providing a collaborative approach to city planning. Access to GIS data by the public upon request builds accountability by creating an interactive window to which citizens can turn to interact with regulatory processes, as mentioned by Echeverría and López (2021). In this regard, Cordella and Paletti (2022) argued that this transparency expands the potential of PVT, as it enables citizens to be aware of and interact with the regulatory processes in other ways. Through the application of GIS, MPKK has been associated with the openness of communication channels that allow citizens to actively participate in the governance and urban planning process.

The transparency and accessibility of this publicly oriented type of dashboard contribute to the accountability of government, as Silva et al. (2023) argued. Residents of MPKK are able to track any aspect of urban development through GIS portals aimed at informing decisions of the municipality that affect them. This accessibility is also aligned with E10 principles on openness and citizen participation, as building trust and engagement and encouraging citizen participation is one of the main drivers of implementing Open Government principles.

Table 3 illustrates how GIS has helped to increase public engagement in a variety of municipal settings by highlighting the importance of data transparency for citizen engagement and trust.

Table 3: GIS-Enabled Data Visualization and Public Engagement in Urban Governance

Location	GIS Application	Outcome in Public Engagement	Authors
Malaysia (MPKK)	Public dashboards for zoning and permits	Enhanced citizen engagement, increased satisfaction with municipal services	Rashid et al., 2024
United Kingdom	Visualized data on urban infrastructure	Increased public awareness of governmental projects and plans	Kitchin, 2022
Singapore	Interactive mapping for urban development	Improved transparency, integrated public participation	Zhu, Wong, & Lee, 2022
Brazil	Public access to regulatory information	Supported participatory urban planning, boosted public trust	Silva et al., 2023

Ethical Consideration

GIS's ability to visualize data and present it in a user-friendly way is a significant improvement in transparency during governance. Open resource GIS portals help citizens see whether permits are approved or denied, what zoning regulations apply, and monitor municipal project development, fostering citizen transparency. Cordella and Paletti (2022) stress that transparency is the basis for gaining public trust and ensuring that government actions are legitimate. MPKK's E10 framework also includes GIS dashboards that allow the public to access interactive maps of the zoning and real-time regulatory information (Rashid, Hamid, & Tan, 2024).

The participatory and interactive nature of GIS also allows for citizens to offer input on zoning and development plans. Hilal et al. (2024) state that GIS dashboards can improve citizen engagement by making regulatory information accessible and understandable, thus empowering citizens to participate in urban planning. This transparency is in line with the E10 framework's aim to encourage collaboration between citizens and local authorities. Public access to data promotes informed discussions around urban development, strengthening MPKK's commitment to transparent and inclusive governance.

In addition, Pisano (2021) noted that resources and a new real-time data basis need to be fully integrated in order for municipalities to respond to high-growth urban areas. But interoperability issues of data compatibility and seamless collaboration need to be addressed in order to expand GIS capacities to the national level. According to Johnson and Lee (2023), interoperability in data governance policies has to be established so that effective collaboration among the different departments of the government takes place. In achieving the scaling of KIDS to the state or national levels, the use of standardized protocols, both in terms of data and ensuring consistency of data quality and effective inter-agency communication, is essential for MPKK.

In this model, MPKK would be able to emulate other municipalities in the state of Malaysia; therefore, they can work together in a single governance model based on data. But Patel and Chen (2023) explained that local governments must invest in digital infrastructure to help meet the demands placed upon GIS applications, and ongoing training of staff will build skills in

how local government employees use GIS and make meaningful inferences from it. It is a scalable model and hence in line with Malaysia's national aspirations for the development of smart cities by placing GIS as the fundamental tool whereby sustainable governance adapts to increased urban growth.

Challenges and Future Directions for GIS in Governance

The development of GIS technology is ongoing, and more research is needed to explore the medium- and long-term effects of GIS on urban governance and regulatory processes. GIS can be used in predictive analytics to enable the municipality to anticipate resource needs, urban expansion requirements, and possible crisis situations, and this should be explored in the future. AI-integrated GIS could be improved to make better predictions and give municipalities data-based information to help them plan and allocate resources, as proposed by Silva et al. (2023). Also, research needs to focus on GIS scalability across municipalities, and particularly those in developing areas where digital infrastructure may be less developed. The comparative study of socio-political contexts may provide lessons for best practices in GIS adoption and ultimately help local governments customize GIS technology for various regulatory requirements as they see fit (Nguyen, Chen, & Lee, 2023). Ethical issues in GIS are another topic that needs to be explored in depth, as there is a need to balance the transparency of data with respect for privacy while ensuring the public has trust in the availability of these data and that data quality is in line with the principles of smart governance.

Table 4 demonstrates some of the key issues that were identified and some of the proposed solutions for implementing GIS for Express Permitting.

Table 4: Key Challenges and Proposed Solutions in GIS Implementation for Express Permitting

Challenge	Description	Source	Proposed Solutions
Infrastructure Costs	High costs associated with GIS software, data storage, and maintenance	Johnson & Lee, 2023; Giffinger & Pichler-Milanović, 2022	Public-private partnerships, government funding for digital infrastructure
Data Privacy and Security	Risks to citizen privacy from unauthorized access to sensitive spatial data	Almeida et al., 2022; Cordella & Paletti, 2022	Implement strong data governance policies, encryption, and regular audits.
Ethical Use of GIS	Balancing transparency with responsible data sharing	Morley et al., 2022; Loukis et al., 2022	Development of ethical guidelines for public data access and usage
Training and Skills Gap	Requirement for specialized skills to operate and manage GIS systems effectively	Loukis et al., 2022; Silva et al., 2023	Comprehensive GIS training programs for municipal employees

Conclusion

The current study expanded the understanding of how GIS can support the E10 regulatory approach in Kulim Municipal (MPKK) in Malaysia and its impact on facilitating the local government-level express permitting process. GIS technology provides one place to share spatial and regulatory information, thereby supporting efficiencies in operations, and also provides a strong public and transparent aspect to smart governance. The comprehensive thematic analysis according to the PRISMA protocol in implementing GIS in the E10 regulatory system at MPKK found three main themes that are closely interconnected, namely operational efficiency, engagement of the public, and ethical considerations. As demonstrated in MPKK, GIS enables express permitting but, more importantly, opens citizens' eyes to the open and transparent nature of regulatory processes. Recommendations for effective GIS integration, however, are presented, such as investment in GIS infrastructure, GIS data privacy and security, and ethical application of GIS, as well as training gaps. By aligning the GIS capabilities with the E10 objectives, municipalities can upgrade regulatory practices with the added advantage of developing a collaborative relationship with the public-management model that would withstand resiliency.

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