IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN:2278-487X, p-ISSN: 2319-7668. Volume 28, Issue 1. Ser. 5 (January. 2026), PP 17-24
www.iosrjournals.org

Analyzing The Role Of GIS In Boundary Demarcation: Post-Evaluation Of Malawi's Constituency And Ward Review

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Abstract:
Background*: The adoption of Geographic Information Systems (GIS) in electoral boundary delimitation has been a transformative step for the Malawi Electoral Commission (MEC), enhancing accuracy, efficiency, and transparency in constituency and ward boundary adjustments. Despite these advancements, the implementation of GIS in boundary delimitation is not without challenges. Effective deployment of the technology requires robust infrastructure, technical expertise, and coordinated administrative processes. Studies have shown that the effectiveness of GIS in electoral boundary delimitation depends not only on technological capacity but also on stakeholder engagement and institutional preparedness[1]. In Malawi, political interference, limited public awareness, and technical limitations have affected the effectiveness of boundary demarcation processes[2]. Nevertheless, the extent to which GIS has improved electoral boundary delimitation, enhanced public confidence, and addressed previous inefficiencies remains unexplored.*
Materials and Methods*: The study combines qualitative and quantitative research approaches to determine the impact of the technology and assess its usability and efficiency. Data collection was based on purposive sampling, targeting technology users and other stakeholders involved in the demarcation processes.*
Results*: The study was significant as it revealed the successes and challenges faced and will assist MEC in preparing for future activities.*
Conclusion: *Overall, GIS has proven to be a useful tool for electoral management, enabling data-driven decisions, promoting equitable representation, and increasing stakeholder trust when implemented effectively.*
Key Word: *GIS; Delimitation; Electoral Boundaries; Technology Integration; Malawi Electoral Commission (MEC)*

Date of Submission: 10-01-2026 Date of Acceptance: 20-01-2026

I. Introduction

The use of GIS in reviewing the boundaries of the constituency and wards by the MEC has been one of the milestones to incorporate technology in the implementation of electoral operations. MEC fully employed the use of GIS during the demarcation of electoral boundaries, which run from July 2021 to November 2022. The demarcation of constituencies and wards aimed to achieve equi-populous numbers of voters, ensuring equal representation across all areas. Considering that it had taken over 20 years since the last boundary delimitation was conducted, the use of GIS was deemed to potentially mitigate previous challenges e.g., boundary overlaps, demographic misrepresentation and logistical inefficiencies.

Despite registering notable benefits, the boundary delimitation processes were faced with obstacles which may call for the necessary infrastructure and robust administrative processes to support the technology. The study employed both quantitative and qualitative methods to, which involved the analysis of geospatial data and interviews with key stakeholders involved in the delimitation process. Thus, comprehensively evaluating the efficiency and effectiveness of GIS in electoral boundary delimitation and registration centre allocation.

II. Material And Methods

A case study design was adopted, focusing on MEC's 2021–2024 boundary delimitation project. This approach supported in-depth investigation within a real-life setting[3]. It facilitated detailed examination of how GIS was adopted, used, and perceived within Malawi's electoral environment, and how institutional and infrastructural contexts shaped outcomes—mirroring the 'input–process–output–impact' structure of the conceptual framework.

The case study design allowed for the integration of both qualitative and quantitative data, enabling a holistic understanding of the research problem. Qualitative data captured the perceptions, attitudes, and experiences of stakeholders directly involved in the delimitation process, while quantitative data from GIS maps and spatial outputs provided measurable evidence of the technology's performance. The quantitative component

focused on technical effectiveness, spatial accuracy, and output reliability of GIS-generated boundaries compared to manual methods with specific focus on Mulanje district's constituency and ward boundary map. Primary and secondary data use

Study Design: A case study design, focusing on MEC's 2021–2024 boundary delimitation project. A mixed-methods approach was employed, combining qualitative and quantitative research strategies for data collection.

Study Location: The study was undertaken in Malawi, where all District Election Officers and Boundary Delimitation Stakeholders. All 36 councils of the country, Malawi Africa

Study Duration: November 2024 to March 2025.

Sample size: 44 survey respondents.

Sample size calculation: The sample size was determined from the number of people who were directly involved in the electoral boundary delimitation, since it was a purposive sampling

Subjects & selection method: The study employed a purposive sampling technique to select respondents who possessed specific knowledge and experience relevant to the research objectives[4]. The target population for this study included officials and technical personnel involved in the boundary delimitation process in Malawi. This comprised staff from the MEC at district level, GIS technicians, and representatives from relevant stakeholders at community level. These individuals were key informants to the research due to their direct involvement in or influence over the delimitation process, making them well-positioned to provide insights on the effectiveness and challenges of using GIS technology. Mulanje district constituency and ward boundary map was used for the quantitative analysis.

Qualitative aspect

The study targeted personnel directly involved in the delimitation exercise, a total of 44 individuals participated and these are as follows:

- Thirty-six (36) MEC district officers (policy and coordination),
- Eight (8) individuals from MEC Head Office who included GIS technicians and other key staff in the delimitation processes (technical implementation),

Quantitative aspect

The quantitative component focused on technical effectiveness, spatial accuracy, and output reliability of GIS-generated boundaries compared to manual methods with specific focus on Mulanje district's constituency and ward boundary map.

Inclusion criteria:

1. Direct involvement in electoral boundary demarcation activities
2. Experience with GIS or spatial data in electoral operations
3. Institutional affiliation with relevant stakeholders
4. Personnel involved in planning, approving, implementing, or evaluating boundary delimitation and registration centre allocation.
5. Individuals who consented to provide information through interviews, questionnaires, or document review

Exclusion criteria:

1. Individuals not engaged in delimitation, mapping, or spatial decision-making
2. Staff whose duties were unrelated to boundary review, GIS, or registration centre allocation.
3. Anyone unwilling or unable to provide informed consent.

Procedure methodology

After written informed consent was obtained, a well-designed questionnaire and interview guiding questions were used to collect data from MEC officials, GIS staff, and local stakeholders who were directly involved in the boundary delimitation exercise. The questionnaire was used to examine the extent to which pre-requisites for GIS technology were used to ensure the efficiency and effectiveness of implementation of the delimitation processes and to identify and analyze key challenges and limitations faced in the implementation of the exercise while using GIS.

These tools captured perceptions of GIS implementation readiness, ease of use, and encountered challenges. For the third objective, GIS-generated maps were compared to historical manual maps to assess representation quality, spatial equity, and accuracy, key 'output' indicators in the conceptual framework. Stakeholder feedback reports were also analysed thematically to gauge perceived legitimacy and trust, contributing to the impact dimension. Such that qualitative tools captured the human and institutional dimensions of GIS use, while quantitative analysis provided evidence of technical effectiveness.

Statistical analysis

Qualitative data was analyzed using thematic analysis, coding for TAM constructs (PU, PEOU, trust, and resistance) and practical themes (e.g., training gaps, data limitations).

Quantitative data, particularly those related to the technical comparison of maps, were analysed using descriptive statistics and comparative spatial analysis. GIS outputs were assessed in terms of spatial accuracy, coverage, and consistency with population and administrative data.

Results were presented in narrative, tabular, and visual formats (maps, charts) to highlight both the perceptual and technical dimensions.

TAM theoretical framework

The Technology Acceptance Model (TAM), developed by Fred Davis in 1986 and rooted in the Theory of Reasoned Action (TRA), is a foundational model explaining user acceptance of technology. TAM posits that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are key determinants of users' intentions to use a technology[5] This model has undergone numerous refinements, including TAM2, TAM3, and its integration into Unified Theory of Acceptance and Use of Technology (UTAUT), extending its application across domains[6] .

As reviewed by O'Dea[7] TAM has matured into a powerful academic framework but is underutilized in practical fields like Human-Computer Interaction (HCI) or GIS-based governance. Nonetheless, it offers significant potential to understand stakeholder attitudes, readiness, and resistance in contexts such as electoral management, where system usability and trust are pivotal.

III. Result

Utilization of GPS Prerequisites

The foundation of successful GIS deployment lies in institutional readiness, staff capacity, and access to appropriate infrastructure. Findings from questionnaires and interviews reveal that majority of the respondents felt well-prepared to work with GIS. Over 85% expressed comfort with using the technology, citing training, availability of spatial data, and reliable hardware and software as primary enablers. This high rate of comfort aligns with the TAM construct of *Perceived Ease of Use (PEOU)*, which posits that ease of system navigation directly influences acceptance and usage.

One participant summarized the institutional support clearly: *"We had all the needed equipment, training sessions, and access to spatial data from NSO and other ministries."* The data further confirm that the Malawi Electoral Commission (MEC) invested substantially in technical training and awareness campaigns to build capacity. This reflects global best practices in GIS integration, as seen in countries like South Africa and Zambia, where similar institutional investments led to smoother deployments and greater public confidence.

Notably, participants widely described the system as efficient, reliable, and easy to use. For instance, a district officer commented: *"We were well trained, had the equipment, and were clear on the processes. GIS made it easier to identify and correct overlaps."* Such feedback directly supports the first research objective: to assess whether MEC created the necessary conditions for effective GIS use. The answer appears to be affirmative in most areas. However, some outliers emerged.

A minority of respondents reported equipment malfunctions and uneven access to resources, suggesting that while MEC made significant progress, disparities remain across districts. One stakeholder mentioned: *"Some of our computers failed to operate properly, delaying some processes."* This underscores the importance of not just provisioning but maintaining GIS infrastructure to ensure consistent performance nationwide.

Beyond technical readiness, stakeholders appreciated the time and cost efficiencies introduced by GIS. Over 70% reported improved boundary accuracy and reduced reliance on manual drawing methods. One respondent described the difference as *"less tedious than drawing by hand."*

A major strength noted was the ability of GIS to facilitate public consultations. The interactive nature of digital mapping enabled communities and stakeholders to engage more meaningfully. A key insight came from one participant who stated: *"Stakeholders could see the boundary options. It made discussions easier and more productive."* This aligns with the TAM's *Perceived Usefulness (PU)* principle, emphasizing how system utility drives adoption. It also reflects international evidence—such as studies from Kenya—that underscore how visualized data improves understanding and stakeholder buy-in.

Impact on Representation and Inclusivity

GIS was widely perceived to have improved fairness, inclusivity, and transparency in the delimitation process. A strong majority rated the boundary review outcomes as satisfactory, and many described the new maps as more balanced and accurate. One participant remarked: *"It was the first time we could visualize voter distribution and adjust boundaries based on data, not assumptions."* This shift, from intuitive or politically driven decisions to data-informed processes, marked a significant milestone in Malawi's electoral modernization.

Inclusivity was another key gain. GIS maps made the consultation process more comprehensible for non-technical stakeholders. A participant noted: *"People were more involved because they could understand the maps and give input."* This feedback aligns with the impact layer of the study's conceptual framework, particularly on inclusive governance and conflict mitigation. It also reinforces the argument that GIS can act as a democratizing tool, allowing for broader civic engagement[8].

However, not all responses were positive. One stakeholder noted: *"The system sometimes froze, and that made it frustrating, especially when under pressure."* This aligns with TAM's concern for system reliability and trust[9]. While these issues were not widespread, they indicate the need for better support infrastructure and responsiveness during high-pressure periods.

Overall, participants reported that boundary accuracy improved and voter distribution was more equitable. One official said: *"This time, you can actually see that most areas are closer to equal in terms of voters."* Such feedback validates the use of GIS in enhancing democratic equity and transparency in Malawi's electoral management.

GIS vs Manual Boundary Demarcation Analysis

To substantiate the qualitative findings, a comparative technical analysis was conducted to evaluate the relative performance of GIS and manual methods in boundary demarcation.

Comparative Technical Analysis

Table 1 indicates that GIS significantly outperformed manual methods in nearly all dimensions. For instance, the automation of population calculations and the simulation of multiple boundary scenarios in GIS facilitated more informed and transparent decision-making. Manual methods, on the other hand, were slower, less accurate, and prone to human error. These differences directly validate stakeholder perceptions and reinforce the role of GIS in enhancing the operational integrity of electoral delimitation.

Table no 1: Comparative Technical Analysis of GIS and Manual Methods

Comparison Dimension	GIS-Based Method	Manual Method
Speed of Map Production	Automated and fast	Time-consuming, mechanical
Population Calculation	Automated using enumeration area data and formulas	Manual calculations using printed maps and tracing
Scenario Simulation	Multiple scenarios simulated using ArcMap	Limited scenario simulation with tracing paper
Data Integration	Allows overlay of multiple data layers (e.g. Google Maps, NSO data)	Manual overlays; poor data merging capacity
Accuracy of Outputs	High spatial accuracy and consistency	Prone to inaccuracies due to human error
Stakeholder Engagement	Interactive maps enabled clearer consultations	Harder to interpret maps limited engagement
Cost Efficiency	Initial high cost but more scalable long-term	Low initial cost but labor-intensive and slow
Transparency	High, due to visual and reproducible outputs	Low; subjective and less reproducible
Operational Efficiency	High; faster turnaround and less prone to error	Low; repetitive and slower process

Figure no 2 quantifies the relative effectiveness of each method based on a normalized scoring system, while Figure 3 illustrates the spatial consistency and alignment achieved through GIS. The spatial simulation demonstrates how GIS-enabled boundaries follow logical, symmetric patterns aligned with geographic features and population data. In contrast, manual methods result in inconsistencies due to limited overlay capacity and visual ambiguity. This supports the argument that GIS provides a technically superior and more democratic basis for electoral boundary decisions[10].

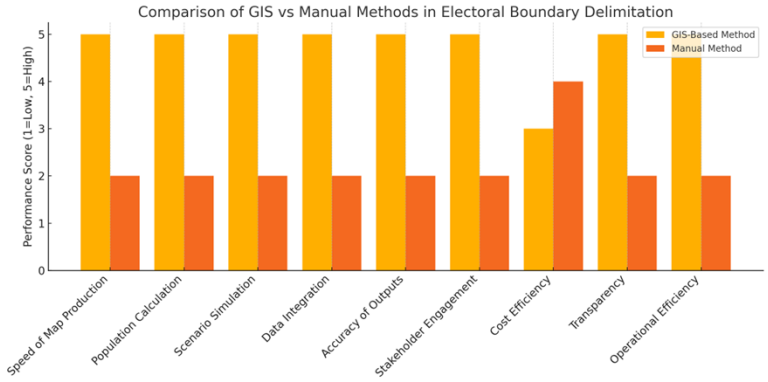

Figure no 1: Bar chart comparison of GIS and manual boundary demarcation methods.

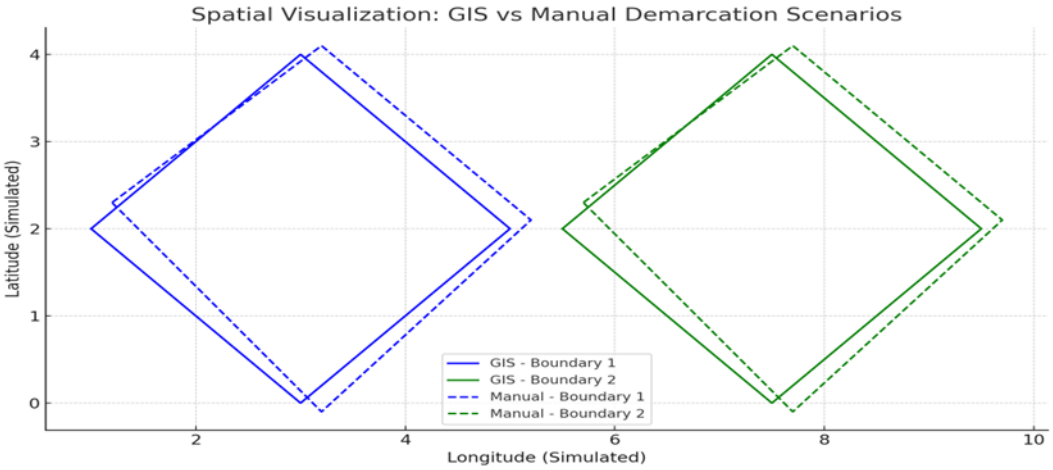

Figure no 2: Simulated spatial representation comparing GIS and manual boundary methods.

Figures 4, 5, and 6 provide a clear illustration of the practical challenges faced during the electoral boundary delimitation in Mulanje District, particularly concerning the positioning of polling centers near constituency and ward boundaries. In Figure 4, which presents a general overview of constituency and ward boundaries, key polling centers—such as Mussa Under-Five Clinic, Greek Orthodox Church Ground, Mombo School, and OVOP—are shown to lie ambiguously along the boundaries. These ambiguities sparked confusion among stakeholders who were uncertain about the exact administrative jurisdictions of the centers.

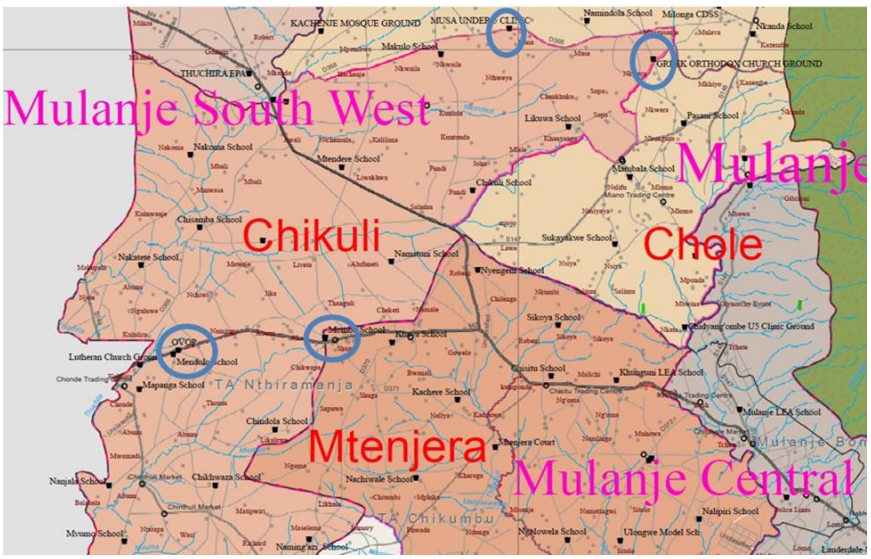

Figure no 3: Constituency and Ward Boundaries for Mulanje:
Source 1 MEC 2025 Maps

Figures 5 and 6, which focus specifically on the OVOP and Mombo School centers, highlight the limitations of manually generated or static "still" maps. These traditional maps lack the functionality to dynamically interact with spatial data, thereby failing to clearly delineate whether the centers fall within one ward or another. This kind of spatial ambiguity undermines confidence in the boundary delimitation process and can affect decisions related to voter assignment and electoral representation

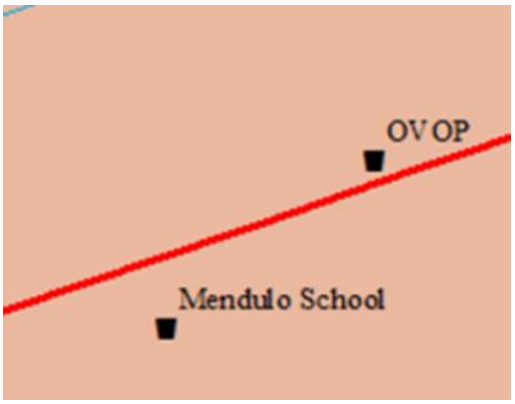

Figure no 4: OVOP registration centre

Figure no 5: Mombo School

The adoption of GIS fundamentally addressed these concerns. GIS allowed for real-time manipulation and multi-scale viewing of electoral maps. Technicians and stakeholders were able to zoom in on ambiguous areas, overlay different data layers, and accurately determine the placement of each polling center. For example, while OVOP and Mombo School appeared to be located directly on the boundary lines in the manual maps, GIS visualization revealed their exact positions within specific administrative areas. This resolved disputes and facilitated consensus among electoral stakeholders.

Moreover, GIS's capability for precision mapping is not just a technical enhancement but a democratic imperative. As emphasized by Eagles, Katz, and Mark[10], the ability to visually analyse spatial data in detail fosters greater transparency and inclusion in boundary decisions. In the case of Mulanje, stakeholders could directly engage with the GIS outputs, leading to more informed and participatory decision-making.

Overall, the integration of GIS into the delimitation process in Mulanje exemplifies the system's transformative potential. Beyond resolving spatial ambiguities, GIS enhances legitimacy and confidence in electoral outcomes by ensuring that decisions are based on accurate, verifiable, and clearly communicated spatial information. The case study demonstrates that when combined with adequate institutional support and stakeholder training, GIS is not merely a technical tool but a driver of electoral equity and governance reform.

IV. Challenges And Limitations In Implementation

Despite the overwhelmingly positive feedback, the study identified several persistent implementation challenges. Key among these were data quality issues, outdated spatial layers, and inconsistent internet connectivity.

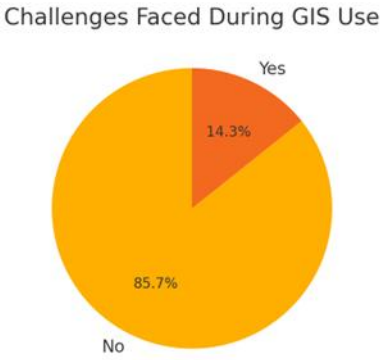

Figure no 6: Challenges Faced During GIS Use

One participant shared: *"We had challenges with aligning GIS layers due to inconsistencies in base maps, and sometimes the technical support was not immediate."* This echoes literature on GIS adoption in low-resource settings, where technical barriers and limited data precision impede outcomes[11]. Similar problems were observed in Tanzania and Nigeria, where boundary reviews were delayed due to incomplete or mismatched spatial datasets[12].

About 14% of participants noted technical or data-related difficulties. These included system crashes, poor internet access, and outdated infrastructure. Furthermore, out dated differences in referencing coordinate systems led to data mismatches. A respondent stated: *"Some roads and schools didn't appear where they actually are, and that caused confusion in discussions."* This mirrors challenges reported in India's GIS-led boundary reform initiative, where data mismatches eroded confidence in system outputs[13]. Such gaps can also frustrate public trust, particularly if communities dispute the legitimacy of map-based decisions.

System failure was another recurring theme. One stakeholder explained: *"At one point the system crashed and we had to go back to manual maps temporarily."* Reliability concerns such as these are well-documented in the TAM literature. System failure, particularly during high-stakes tasks, can diminish confidence and trigger fallback to traditional methods[6].

Financial sustainability was also raised. While initial investments were secured through government and donor support, maintaining systems across all districts has proven difficult. One participant noted: *"We had the basics, but keeping everything running smoothly was hard. We had to share equipment sometimes."*

Organizational resistance, while not dominant, was reported in pockets, particularly among non-technical staff who were slow to embrace the new system. This highlights the need for targeted change management interventions, even where technical capacity exists[15].

Chapter Summary

Malawi's 2024 boundary delimitation exercise demonstrated significant progress in the application of GIS technology in democratic governance. Most participants—both technical staff and decision-makers—affirmed that GIS made the process faster, fairer, and more transparent.

Institutional preparedness and technical training were cited as key enablers. Participants valued the accuracy and speed introduced by GIS tools, particularly in stakeholder consultations and map simulations. The technology also improved inclusivity by making spatial information easier to understand and debate.

On the other hand, the study also identified some challenges which include, data mismatches, technical hiccups, and financial sustainability threaten the continuity of GIS adoption.

V. Discussion

Main results of the study

Utilization of GIS Prerequisites:

The study found that MEC had largely met the core requirements for effective GIS deployment. Institutional readiness, access to infrastructure, and targeted training programs contributed to widespread acceptance of the system. Over 85% of respondents indicated comfort with using GIS, attributing this to capacity-building efforts and access to spatial data. These results support TAM's PEOU construct, showing that user training directly affects system uptake.

Positive Impacts on Delimitation Outcomes:

Participants acknowledged improvements in boundary accuracy, consultation processes, and efficiency. GIS facilitated interactive consultations and provided tools to visualize voter distribution and test multiple

scenarios—enhancing stakeholder participation and decision-making transparency. These findings affirm TAM's PU dimension and confirm global trends noted in Kenya, Zambia, and South Africa.

Implementation Challenges

Despite the positives, challenges persisted. These included, data quality issues, outdated base maps, system failures, and uneven distribution of technical resources. Around 14% of respondents noted significant issues such as software crashes, slow systems, or misaligned spatial data. Some participants also highlighted organizational resistance, especially among non-technical staff, and financial constraints affecting long-term sustainability.

Perceived Inclusivity and Representation:

Stakeholders widely perceived GIS as advancing representation and inclusivity. Constituency sizes became more equitable, and public consultations were enhanced through the visual clarity GIS provided. This aligns with democratic principles of fairness and supports findings from studies conducted in Ghana and India, where GIS has been used to correct representational imbalances.

VI. Conclusion

The implementation of GIS in Malawi's 2024 boundary delimitation exercise represents a substantial step forward in integrating technology into electoral governance. The findings support the conclusion that GIS, when supported by adequate infrastructure, institutional readiness, and capacity-building, can significantly enhance the accuracy, efficiency, and legitimacy of the delimitation process.

However, successful deployment also depends on continued investment, improved data quality, and proactive management of operational and political risks. GIS is not a panacea—it is only as effective as the data and institutions supporting it. The presence of system failures, resistance from users, and gaps in data accuracy indicate that the transition from manual to digital methods remains a work in progress.

Overall, GIS has proven to be a useful tool for electoral management, enabling data-driven decisions, promoting equitable representation, and increasing stakeholder trust when implemented effectively.

References

[1]. S. Eagleson, "Gis And Electoral Mapping: Redrawing The Lines Of Democracy," Cartography, Vol. 31, No. 2, Pp. 37–44, 2002.
[2]. J. Chunga, "Technological Challenges In Malawi's Gis Adoption: An Evaluation," Malawi Journal Of Ict And Policy, Vol. 2, No. 1, Pp. 45–59, 2020.
[3]. J. Gerring, Case Study Research: Principles And Practices, 2nd Ed., Cambridge University Press, 2017.
[4]. C. R. Kothari, Research Methodology: Methods And Techniques, 2nd Ed., New Age International Publishers, 2004.
[5]. F. D. Davis, "Perceived Usefulness, Perceived Ease Of Use, And User Acceptance Of Information Technology," Mis Quarterly, Vol. 13, No. 3, Pp. 319–340, 1989.
[6]. V. Venkatesh, M. G. Morris, G. B. Davis, And F. D. Davis, "User Acceptance Of Information Technology: Toward A Unified View," Mis Quarterly, Vol. 27, No. 3, Pp. 425–478, 2003.
[7]. S. O'dea, "Revisiting The Technology Acceptance Model: A Scoping Review Of 100 Empirical Studies," Journal Of Information Systems Research, Vol. 12, No. 2, Pp. 101–125, 2024.
[8]. W. J. Craig, T. M. Harris, And D. Weiner (Eds.), Community Participation And Geographic Information Systems, Taylor & Francis, 2002.
[9]. V. Venkatesh And H. Bala, "Technology Acceptance Model 3 And A Research Agenda On Interventions," Decision Sciences, Vol. 39, No. 2, Pp. 273–315, 2008.
[10]. M. Eagles, R. S. Katz, And D. Mark, "Controversies In Political Redistricting: Gis, Geography, And Society," Political Geography, Vol. 19, No. 2, Pp. 135–139, 2000.
[11]. N. Patel And M. Wahman, "The Quality Of Democracy In Africa: Elections, Voting And Legitimacy," Journal Of Modern African Studies, Vol. 53, No. 3, Pp. 387–416, 2015.
[12]. J. S. Omotola, "Democracy And Electoral Reforms In Nigeria," African Journal Of Political Science And International Relations, Vol. 13, No. 1, Pp. 15–26, 2019.
[13]. A. Singh And P. Ashesh, "Population Equality In Boundary Delimitation: A Spatial Justice Analysis Of India," Asian Journal Of Spatial Democracy, Vol. 7, No. 2, Pp. 115–134, 2020.
[14]. I. Ajzen, "The Theory Of Planned Behaviour," Organizational Behaviour And Human Decision Processes, Vol. 50, No. 2, Pp. 179–211, 1991.