Title

DESIGN AND IMPLEMENTATION OF MALAWI BUDGET TRACKING SYSTEM: ENHANCING PUBLIC FINANCIAL TRANSPARENCY AND CITIZEN ACCOUNTABILITY IN MALAWI

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ABSTRACT

The Malawi Public Budget Tracking System is a web-based system designed to improve transparency, accountability, and public participation in the management of public funds in Malawi. The management of public budgets involves several activities, including budget allocation, expenditure monitoring, development project implementation, and reporting. However, limited access to budget information and difficulties in monitoring project progress can make it challenging for citizens to determine whether public funds are being used for their intended purposes. These challenges may reduce public trust and make it difficult to identify delays, irregularities, and incomplete development projects. The proposed MPBTS aims to address these challenges by providing a centralized platform for recording, monitoring, and reporting public budget information. The system enables authorized users to enter and manage budgets, track expenditures, monitor development projects, and generate comprehensive reports summarizing the entire budget lifecycle, from initial allocation to project completion. Geographic Information System (GIS) mapping is incorporated to display project locations and support geographical monitoring of development activities. In addition, AI-assisted moderation is proposed to help identify potentially inappropriate, irrelevant, or suspicious citizen reports for human review. Security measures, including role-based access control, audit trails, and data protection mechanisms, are included in the system design to improve the reliability and accountability of information management. The system is expected to make budget information more accessible, simplify project monitoring, and support informed decision-making by relevant stakeholders. Ultimately, Malawi Public Budget Tracking System seeks to strengthen public oversight and promote responsible management of public resources in Malawi.

KEYWORDS: Public Budget Tracking, Transparency, Accountability, Geographic Information System (GIS), AI-Assisted Moderation, Project Monitoring, Public Expenditure.

INTRODUCTION

Public budgeting plays an important role in national development by determining how government funds are allocated and used for public services and development projects. In Malawi, proper monitoring of public funds is necessary to promote transparency, accountability, and responsible resource management. However, limited access to budget information and difficulties in tracking project progress can make it challenging for citizens to determine whether funds are being used for their intended purposes. The Malawi Public Budget Tracking System is a proposed web-based platform designed to simplify the management and monitoring of public budgets. It allows authorized users to record budget allocations, track expenditure, monitor development projects, and generate comprehensive reports covering the budget lifecycle. The system also integrates GIS mapping to display project locations and AI-assisted moderation to help identify suspicious or inappropriate citizen reports for human review. Furthermore, security features such as role-based access control and audit trails are included in the system design to support secure and accountable information management. Overall, Malawi Public Budget Tracking System aims to improve access to public budget information, strengthen citizen participation, and support better monitoring of government-funded projects in Malawi.

Background of the Study

The management of public funds in Malawi faces challenges related to transparency, accountability, and effective monitoring of government expenditure. Citizens often have limited access to reliable information about how government budgets are allocated, how much money is spent, and whether the funds are used for their intended purposes. Monitoring development projects across different districts can also be difficult, particularly

when information about project progress, expenditure, and completion is scattered across different records. These challenges make it difficult to compare allocated budgets with actual spending, identify delayed or incomplete projects, and determine whether public resources are being managed effectively. Furthermore, inadequate access to budget information limits citizens' ability to participate in monitoring government activities and holding responsible authorities accountable. The absence of clear, accessible, and regularly updated information can also reduce public trust in government institutions. Consequently, these challenges highlight the difficulties faced by citizens and officials in tracking public expenditure, monitoring development projects, and ensuring responsible management of public funds in Malawi.

RESEARCH OBJECTIVES

General Objectives

- To develop a Malawi Public Budget Tracking System that improves transparency, accountability, and monitoring of public budgets and development projects in Malawi by providing a centralized platform for tracking budget allocations, expenditures, project progress, and citizen feedback, while promoting responsible use of public funds.

Specific objectives

- To develop a system for recording and managing public budget allocations and expenditures, enabling accurate storage, tracking, and retrieval of financial information.
- To enable the monitoring of development projects and their progress across different districts in Malawi, including project status, milestones, and implementation activities.
- To integrate GIS mapping for displaying the geographical locations of government-funded development projects, helping users identify project locations and monitor their distribution across districts.
- To implement citizen reporting features that allow the public to submit feedback, report project-related problems, and raise concerns about the use of public funds.
- To incorporate AI-assisted moderation to help classify citizen reports, identify urgent concerns, detect possible duplicate submissions, and flag reports requiring further human review.
- To generate comprehensive reports showing budget allocations, expenditure, remaining balances, and project implementation progress, supporting informed decision-making and financial accountability.
- To implement security measures, including role-based access control and audit trails, to restrict access to authorized functions, record important system activities, and support secure and accountable management of budget information.

LITERATURE REVIEW

Olarewaju, Rufai, and Gallage (2021), in their research article E-Transparency and Government Budgetary Corruption: A Social Marketing and Transformation Case from Nigeria, examine how information and communication technology, including social media, can support citizen engagement in government budgeting. Their research discusses the use of digital communication to promote transparency and encourage public involvement in budget processes. This study is relevant to MPBTS because the proposed system aims to improve access to budget information and provide a digital channel through which citizens can submit reports about development projects.

The International Budget Partnership (2021), in

its report Open Budget Survey 2021: Malawi, examines the availability of government budget information and opportunities for citizens to participate in budget processes. The report gave Malawi a budget transparency score of 20 out of 100 and a public participation score of 13 out of 100. These findings highlight challenges in making budget information accessible and encouraging citizen involvement in public financial management. This research supports MPBTS because the proposed system aims to make budget allocations and expenditure information easier to access and enable citizens to participate in monitoring development projects.

The International Monetary Fund (2023), in its report Malawi: First Review Under the Staff-Monitored Program with Executive Board Involvement, discusses reforms to Malawi's public financial management systems. The report explains that the government was expanding the coverage of the Integrated Financial Management Information System (IFMIS) and working to improve financial reporting, expenditure controls, and accountability. It also highlights the importance of producing comprehensive and timely fiscal reports. This research is relevant to MPBTS because it demonstrates ongoing efforts to improve public financial management in Malawi. The proposed system focuses on complementing these efforts by presenting budget information alongside development-project progress, geographical locations, and citizen reports.

Jin and Wang (2025), in their research article Digital Budget Supervision Governance and Local Government Fiscal Transparency, investigate the relationship between digital budget supervision and fiscal transparency using data from 288 prefecture-level cities in China. Their findings indicate that digital budget supervision can improve local government fiscal transparency. The study demonstrates the potential value of digital technology in strengthening financial oversight and making government financial activities more transparent. Although the research focuses on China rather than Malawi, its findings are relevant to Malawi Public Budget Tracking System because the proposed system aims to improve budget monitoring, expenditure tracking, and public accountability in Malawi.

METHODOLOGY

The Malawi Public Budget Tracking System adopts the Agile Software Development Methodology. Agile was selected because it allows the system to be developed in small modules, tested regularly, and improved as requirements change. This approach supports the development of the system's main functions, including budget management, expenditure tracking, project monitoring, citizen reporting, GIS mapping, and financial reporting. The development process involves requirements identification, system design, module implementation, testing, and continuous improvement.

Research and Development Approach

The Malawi Public Budget Tracking System follows a software research and development approach to identify problems in public budget monitoring and develop a digital system to address them. The research phase involves reviewing existing literature, budget transparency reports, and public financial management systems to understand the challenges associated with budget information, expenditure tracking, and development-project monitoring in Malawi. The development phase translates the identified requirements into a functional software system. It involves designing the system architecture and database, developing the user interface, and implementing the main modules, including budget management, expenditure tracking, GIS mapping, citizen reporting, and financial reporting. The system also incorporates role-based access control and audit trails to support security and accountability, while AI-assisted moderation flags citizen reports that may require human review.

The developed system is then tested to determine whether its functions operate according to the specified requirements. The results are used to identify errors, improve functionality, and assess the system's suitability for supporting public budget tracking and development-project monitoring in Malawi.

FUNCTIONAL MODULES

- **User Authentication and Access Control Module**
  This module manages user registration, login, and access permissions within the Malawi Public Budget Tracking System. It uses role-based access control (RBAC) to assign permissions according to user responsibilities. Administrators, financial officers, and public users can access different functions based on their roles. This helps prevent unauthorized access to sensitive financial information and protects important system records. The module supports secure system operations and ensures that users interact with features appropriate to their assigned responsibilities.

- **Budget Allocation and Expenditure Tracking Module**
  This module records and manages public budget allocations and expenditure information. It allows authorized users to enter budget details, allocate funds to different sectors and development projects, and record expenditure. The module helps compare planned budgets with actual spending to identify differences and monitor the use of public funds. It also supports the tracking of remaining balances and financial performance. By organizing financial information in one system, the module helps improve financial monitoring, reporting, and accountability in public budget management.

- **Development Project Monitoring Module**
  This module supports the monitoring of government-funded development projects across different districts in Malawi. It stores project details, including project names, locations, allocated budgets, implementation status, and progress updates. Authorized users can update project information to show whether activities are planned, ongoing, delayed, or completed. This information helps users follow project implementation and compare progress against planned activities. The module also supports the identification of projects that may require attention, helping relevant authorities improve project supervision and the management of public resources.

- **Citizen Engagement and Reporting Module**
  This module allows citizens to submit reports, feedback, and concerns about government-funded development projects. Citizens can use it to report issues such as project delays, incomplete work, or concerns about implementation. The submitted information can help relevant authorities understand community needs and identify problems requiring investigation. AI-assisted moderation may help classify reports, flag urgent concerns, and identify possible duplicate or inappropriate submissions. However, flagged reports should be reviewed by a human moderator before decisions are made. This module promotes communication, citizen participation, and public accountability.

- **Financial Reporting and Analytics Module**
  This module presents public budget and expenditure information through reports, summaries, and dashboard visualizations. It helps authorized officials monitor financial performance and understand how funds are distributed and spent. The module can display budget allocations, recorded expenditure, remaining balances, and development project progress. It also supports comparisons between planned budgets and actual spending, helping users identify financial differences that may require further investigation. By presenting information in an organized format, the module supports informed decision-making, financial planning, and accountability in the management of public funds.

- **GIS Mapping and Location-Based**

Tracking Module
This module uses Geographic Information System (GIS) technology to display government-funded development projects according to their geographical locations. An interactive map can show project locations across different districts in Malawi, helping users understand where public funds are being invested. Users can explore projects and apply filters based on district, sector, or implementation status where these features are available. The module improves geographical visibility and supports project monitoring by making location information easier to understand. It can also help identify areas with development projects and support the review of project distribution.

- **Audit Trail and Activity Logging Module**
  This module records important activities performed within the system, such as changes to budget records, project updates, and other authorized actions. Each recorded event can include information such as the activity performed, date and time, user role, and affected record reference, depending on the system implementation. These records help administrators review system activities and trace changes when questions arise. Activity logging supports accountability by providing a history of important operations. However, audit logs should be protected against unauthorized modification and should not be treated as proof that every recorded action was correct.

- **Language Support Module**
  This module aims to make the Malawi Public Budget Tracking System easier for citizens to understand by supporting English, Chichewa, and Chitumbuka. English can serve users who are comfortable with formal administrative and financial terminology, while Chichewa and Chitumbuka can help communicate important information to more local communities. Language support may cover navigation menus, instructions, report submission forms, project information, and public guidance. Providing translations can reduce language barriers and encourage wider citizen participation. The module should use clear, accurate translations so that financial information and reporting instructions retain their intended meaning.

- **Budget Workflow Management Module**
  This module manages the movement of budget information through defined stages, such as submission, review, approval, allocation, expenditure monitoring, and reporting. It helps organize budget-related activities by showing the current status of each budget record and identifying the next required action. Authorized users can review submitted information and process it according to their assigned responsibilities and configured permissions. The workflow can also maintain records of decisions and changes to support traceability. By structuring budget activities into clear stages, the module aims to reduce confusion, improve coordination, and strengthen accountability throughout the budget management process.

SYSTEM DESIGN AND DEVELOPMENT

System Design

The system design defines the structure, components, database, and interactions between users and the application. MPBTS uses a layered architecture consisting of the presentation layer, backend services, and database layer. The presentation layer uses React and TypeScript to provide an interactive and user-friendly interface. Supabase provides backend services, including authentication and cloud storage, while PostgreSQL manages structured data. The system supports administrators, financial officers, and public users, with access controlled according to user roles. Its main modules include budget allocation, expenditure tracking, district and sector

management, development project monitoring, citizen reporting, financial reporting, and activity logging. These components work together to support public budget monitoring.

Database Design

PostgreSQL was selected as the relational database management system for storing and organizing information within MPBTS. The database structure covers user accounts, budget allocations, expenditure records, districts, sectors, development projects, citizen reports, and audit logs. Relationships between these records allow financial information to be associated with relevant projects, locations, and system activities. For example, expenditure records can be linked to specific development projects, making it easier to monitor how allocated funds are used. The database design aims to maintain data consistency, reduce unnecessary duplication, and support efficient information retrieval. It also provides a foundation for generating budget summaries, monitoring project progress, and preparing financial reports.

System Development

MPBTS was developed using React and TypeScript for the frontend, Supabase for backend services, and PostgreSQL for structured data management. Visual Studio Code was used as the development environment, while GitHub supported source-code version control. Development followed an iterative approach, allowing individual modules to be developed, tested, and refined progressively. The main activities included implementing user authentication, role-based access control, budget allocation, expenditure tracking, project monitoring, citizen reporting, and financial dashboards. These components were designed to work together to support public budget monitoring and improve access to financial information. The development process focused on creating a functional prototype that demonstrates how technology can support transparency and accountability in public spending.

Security and Access Control

Security was considered during the design and development of Malawi Public Budget Tracking System to help protect system information and control access to important functions. Authentication mechanisms are intended to verify users before they access protected areas of the application. Role-based access control separates responsibilities among administrators, financial officers, and public users. Row-Level Security (RLS) can provide additional database protection by restricting access to records according to configured policies. Input validation helps prevent incorrect or unexpected data from being submitted, while activity logging supports accountability by recording important system actions. These measures are intended to improve data protection and reduce unauthorized access. However, their effectiveness depends on correct implementation, configuration, and testing.

System Testing

System testing was conducted to assess whether Malawi Public Budget Tracking System functions according to its requirements. The main testing areas include user authentication, budget data storage, access permissions, budget approval workflows, and citizen report submission. Financial reporting functions also require verification to ensure that displayed totals match the recorded budget allocations and expenditure. Testing helps identify errors, confirm that system components interact correctly, and determine whether users can complete their intended tasks. Access-control tests should verify that each role can access only the functions permitted to it. Citizen reporting tests should examine whether reports are submitted and stored correctly. Any identified problems should be corrected and retested. The results help to assess the prototype's reliability, functionality, and readiness for further development.

RESULTS AND EVALUATION

Functional Test Results

Functional testing was conducted to assess whether the Malawi Public Budget Tracking System performs its intended functions according to the specified requirements. The testing focused on user authentication, data integrity, budget approval workflows, citizen reporting, AI-assisted report moderation, GIS mapping, and final budget reporting. The tests were designed to verify that the system accepts valid inputs, processes user actions correctly, stores information appropriately, and restricts unauthorized operations. They also aimed to identify errors and confirm that the different modules work together as expected. Each test case included specific inputs, expected results, and actual system behavior. Table 1 presents the functional test cases and expected system behavior.

The actual result for each test is recorded after executing the test in the system. Each test can then be classified as Pass or Fail based on whether the observed behavior meets the expected result.

Evaluation

The Malawi Public Budget Tracking System is evaluated based on its ability to improve budget tracking, data accuracy, security, administrative workflows, and citizen participation. The evaluation considers the system's authentication mechanisms, storage of budget information, decision-making workflows, citizen feedback features, and reporting functions.

The project report also identifies user feedback on the platform's efficiency, security, and ease of use. Suggestions for improvement include adding more graphical charts, improving mobile device support, and providing advanced filtering options for reports.

Overall, the report concludes that the system addresses its core objectives of improving public budget monitoring, transparency, accountability, and citizen engagement.

Informal Feedback

Informal user feedback was considered to understand users' experiences with the Malawi Public Budget Tracking System. The feedback focused on the system's ease of use, efficiency, security, and usefulness in tracking public budgets and development projects. The feedback was generally positive. Users also suggested improvements, including adding more graphical charts, improving support for mobile devices, and introducing advanced filtering options for reports. These suggestions indicate areas where the system could be improved to make it more useful and accessible.

Limitations

- Users in areas with poor or unstable internet connections may experience difficulties accessing online services and synchronizing information.
- The system depends on the information entered by users. If budget records or project details are incomplete or incorrect, the information displayed may not accurately represent the actual situation.
- Citizens may not actively submit reports or provide feedback, which could reduce the amount of community information available for monitoring projects
- The system requires ongoing maintenance, software updates, hosting, backups, and technical support, which may require additional financial resources.
- The Malawi Public Budget Tracking System is not currently connected to official government financial systems or databases. As a result, budget information may need to be entered or updated manually instead of being shared automatically between the platform and government agencies. This may lead to delays in updating information and make it difficult to obtain real-time, verified government financial data. Future integration with relevant government agencies would improve data sharing, accuracy, and transparency

DISCUSSION

The Malawi Public Budget Tracking System is a web-based system developed to improve the management, monitoring, and transparency of public budget information in Malawi. As explained in the project report, the system addresses problems associated with paper-based records, scattered financial information, delays in accessing budget details, and difficulties in monitoring public development projects. It provides a centralized platform where budget information, expenditure records, project updates, and citizen reports can be managed and accessed according to user permissions.

The system supports different users, including the Accountant General, Minister of Finance, Sector Officers, Moderators, Administrators, and citizens. Each user has specific responsibilities. The Accountant General handles budget preparation, while the Minister of Finance reviews and approves or rejects budgets. Sector Officers update public project information and upload supporting documents. Moderators review reports submitted by citizens, while Administrators manage user accounts, user roles, and system settings. Citizens can view budget information, monitor development projects, and submit reports about issues affecting their communities.

Another important part of Malawi Public Budget Tracking System is its budget and expenditure monitoring functionality. The system allows budget figures and spending information to be organized by district and sector. Its dashboard and reporting features help present financial information in a clearer format, making it easier for users to understand budget allocations, expenditure, and project progress. The system also supports the monitoring of development projects, helping connect financial information with activities taking place in different communities.

Citizen engagement is another important feature of the system. Citizens can submit reports by selecting a project, district, and category, such as health, education, infrastructure, or agriculture. They can describe the issue and attach a photograph as supporting evidence. These reports are recorded for review by moderators. This feature encourages public participation and gives citizens a way to raise concerns about development projects in their communities.

The system also emphasizes security and accountability. It uses Role-Based Access Control (RBAC) to ensure that users can access functions according to their assigned responsibilities. Authentication helps verify user identities, while activity logs and audit trails support the tracking of important system activities. The project uses React and TypeScript for the frontend, Supabase for backend services, and PostgreSQL for database management. These technologies support the development of an interactive platform for managing and presenting budget information.

The testing process described in the report covers authentication, data integrity, administrative workflows, and citizen feedback. The report also records generally positive user feedback: users found the interface easy to understand, and the dashboard helped present budget information clearly. Administrators also indicated that the system was useful for tracking and managing budget records. Users suggested improvements such as more graphical charts, better mobile support, and advanced report filtering.

CONCLUSION

The development of the Malawi Public Budget Tracking System represents an important step towards the digital transformation of public budget monitoring in Malawi. The project demonstrates the application of software engineering principles in designing a system that responds to the need for more organized, accessible, and transparent management of public financial information.

The project has brought together database management, web technologies, security controls, and citizen engagement features in one platform. It also provides a basis for further research and development in digital governance, particularly in improving how public resources are monitored and how citizens participate in accountability processes.

Ultimately, the success of Malawi Public Budget Tracking System will depend on its continued improvement, the reliability of the information entered into the system, and collaboration with

relevant stakeholders. With further development and appropriate institutional support, the system has the potential to contribute to more accountable and transparent public financial management in Malawi.

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