

A Suitability Analysis Framework for Strengthening Comprehensive Land Use Planning in LGUs

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Abstract: This study developed and evaluated a suitability analysis framework aimed at strengthening Comprehensive Land Use Planning (CLUP) in Local Government Units (LGUs) in the Philippines. As LGUs face increasing pressures from rapid urbanization, environmental degradation, and disaster risks, the need for systematic and evidence-based planning approaches has become more critical. Existing planning practices, while guided by national standards, often rely on fragmented data and limited spatial analysis, affecting the consistency and quality of land use decisions. In response, this research proposes a framework that integrates Geographic Information Systems (GIS) and multi-criteria evaluation to support more objective and data-driven planning. The framework utilizes environmental, socio-economic, and hazard-related datasets to assess land suitability through a structured process involving criteria identification, weighting, and spatial overlay analysis. These processes generate suitability maps that assist planners in identifying appropriate areas for development while incorporating risk and sustainability considerations. The framework is aligned with CLUP guidelines from the Department of Human Settlements and Urban Development (DHSUD), ensuring its practical applicability. To evaluate the framework, consultations and assessments were conducted with professionals in land use planning and geospatial analysis, focusing on usability, clarity, and potential contribution to planning outcomes. Findings indicate that the framework enhances transparency, consistency, and decision-making quality, enabling LGUs to better align land use allocations with development goals and disaster risk reduction strategies. Overall, the study contributes a practical and adaptable approach to improving local planning processes and supports the integration of geospatial tools in evidence-based land use planning.

Keywords: Suitability Analysis, Comprehensive Land Use Planning, Geographic Information Systems, Spatial Analysis, Land Use Planning, Web-Based Suitability Analysis.

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I. INTRODUCTION

Land use planning plays a vital role in guiding local development, safeguarding communities from natural hazards, and promoting sustainable resource management. In the Philippines, Local Government Units (LGUs) are mandated to prepare a Comprehensive Land Use Plan (CLUP) to systematically allocate land for settlements, protection, production, and infrastructure development. While the Department of Human Settlements and Urban Development (DHSUD) provides formal guidelines for CLUP preparation, the level of implementation and analytical rigor varies widely among LGUs, particularly in the technical

and data-driven components of the planning process. These variations often result in inconsistencies in planning outputs and limit the effectiveness of land use policies in addressing emerging environmental and development challenges.

One of the most critical components of CLUP preparation is land suitability analysis, which evaluates the appropriateness of specific areas for various land uses based on spatial, environmental, socio-economic, and hazard-related factors. However, in practice, many LGUs continue to rely on manual, fragmented, and non-standardized analytical procedures. These approaches often produce results that are difficult to validate, reproduce, and technically justify during

planning reviews. Contributing to these challenges are limited technical capacity, insufficient integration of hazard and environmental datasets, inconsistent application of multi-criteria evaluation methods, and the lack of standardized analytical tools to support evidence-based decision-making.

In recent years, national agencies have significantly expanded the availability of geospatial datasets, including hazard information from GeoRiskPH, land cover data from NAMRIA, and various socio-economic indicators. These resources present substantial opportunities to enhance land use planning by enabling hazard-informed and data-driven decision-making. However, despite these advancements, the practical utilization of such datasets at the LGU level remains limited. This gap is largely due to the absence of an operational framework and systematized workflow that can effectively translate raw spatial data into actionable suitability analysis outputs.

In response to these challenges, this study proposes the development of a Suitability Analysis Framework that integrates Geographic Information Systems (GIS), spatial data, multi-criteria decision analysis, and system development methodologies. The framework aims to provide a structured, transparent, and reproducible approach to suitability analysis, enabling LGUs to improve the consistency and technical rigor of their planning processes. By incorporating automated analytical workflows and standardized evaluation methods, the study reduces subjectivity and enhances the reliability of land use decisions.

This study contributes to strengthening evidence-based planning in LGUs by improving the integration of hazard and environmental data, supporting disaster risk reduction, and aligning analytical outputs with DHSUD's resilience-based planning principles. It also highlights the role of data science and spatial decision support systems in modernizing land use planning, providing a practical and adaptable solution that bridges the gap between existing planning guidelines and actual implementation at the local level.

II. METHODOLOGY

This study utilized a Developmental Research Design, also referred to as Design and Development (D&D) research, which is commonly used in information systems and technology projects aimed at producing tools, frameworks, or models (Richey & Klein, 2014). The objective of the study was not merely to describe or evaluate but to design, construct, and refine a Suitability Analysis Framework that systematizes the suitability analysis component of CLUP preparation.

To guide the system development process, the researcher adopted the Agile software development model as the underlying methodological framework. Agile is a flexible and iterative approach that promotes adaptive planning, incremental development, continuous improvement, and close collaboration among stakeholders. It enables the system to respond effectively to evolving requirements and changing conditions throughout the development lifecycle, ensuring that outputs remain aligned with user needs and project objectives (Beck et al., 2001). This approach is well-suited to developing a suitability analysis prototype for Comprehensive Land Use Planning, as it allows the system to evolve based on ongoing feedback from planners, GIS specialists, and LGU personnel. Because land-use suitability modeling involves multiple analytical steps, data dependencies, and domain-specific requirements, Agile supports incremental refinement of datasets, workflows, and system functionalities. Iterative development also ensures that the framework and prototype remain aligned with the practical needs of the Pasig City LGU while maintaining scalability for broader application in other LGUs.

By integrating the systems development approach with Agile, the project adopted a framework that was both structured and adaptable. Each cycle supported improvements to data processing routines, hazard and environmental overlays, suitability scoring methods, and user interface components. This iterative validation process grounded the system in real-world LGU contexts, contributing significantly to the relevance, usability, and overall effectiveness of the suitability analysis framework.

➤ *Research Locale*

This study was situated within the Philippine planning context, where Local Government Units (LGUs) are mandated to prepare Comprehensive Land Use Plans (CLUPs) in accordance with the guidelines of the Department of Human Settlements and Urban Development (DHSUD). The proposed suitability analysis framework was developed with consideration of the country's planning standards, data availability, and hazard environment.

For the prototype implementation, the study specifically focuses on Pasig City, a highly urbanized local government unit in Metro Manila known for its diverse land use patterns, dense built environment, and exposure to multiple natural hazards, particularly flooding, liquefaction, and earthquake ground shaking. Pasig City provides an ideal test case due to the availability of geospatial datasets and its active engagement in evidence-based urban planning and disaster risk reduction initiatives.



Fig 1 Location Map of Pasig City

Figure 1 presents the location of Pasig City within the National Capital Region (NCR). This map provides spatial context for the study, helping readers visualize the city's geographic position, administrative boundaries, and relation to adjacent LGUs. The map also underlines the relevance of conducting suitability analysis in a hazard-exposed and highly urbanized area. The Pasig City which serves as the prototype area for the suitability analysis framework. The study utilized hazard and exposure datasets sourced from GeoRiskPH, the national platform providing authoritative information on earthquakes, floods, landslides, and exposure. Specifically, the prototype incorporated GeoRiskPH layers such as active fault, flood susceptibility, landslide susceptibility, and administrative boundaries. To support suitability modeling, additional spatial datasets needed for Pasig City, including elevation and slope data, land cover,

road networks, and barangay boundaries, were also integrated into the workflow. These datasets were employed primarily to validate the framework's data processing pipeline, geospatial analysis procedures, and suitability scoring mechanisms.

III. RESULTS AND DISCUSSION

The consolidated results of the IT Experts' Evaluation of the Suitability Analysis Framework for Strengthening Comprehensive Land Use Planning (CLUP) in Local Government Units (LGUs) based on the ISO/IEC 25010 Software Product Quality Model. The framework was evaluated across eight quality characteristics: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

Table 1 Evaluation Summary Results Based on ISO/IEC 25010

Software Quality Characteristics	Overall Mean	Verbal Description
Functionality Suitability	3.83	Highly Functional
Performance Efficiency	4	Highly Efficient
Compatibility	3.75	Highly Compatible
Usability	3.88	Highly Usable
Reliability	3.75	Highly Reliable
Security	4	Highly Secured
Maintainability	3.75	Highly Maintainable
Portability	3.83	Highly Portable

Among the evaluated attributes, performance efficiency and security obtained the highest overall mean scores of 4.00, verbally interpreted as Highly Efficient and Highly Secured, respectively. These results reflect the framework's strong capability to process spatial data, execute suitability analyses, and render GIS-based outputs efficiently while maintaining robust protection of planning data. The high-performance efficiency aligns with the system's cloud-based deployment on AWS EC2, optimized database management through AWS RDS (PostgreSQL), and integration of ArcGIS services, which collectively support fast response times and stable analytical operations. Similarly, the high security rating is consistent with the framework's use of SSL

encryption, role-based authentication via Laravel 11, and controlled access to planning and hazard datasets, ensuring confidentiality, integrity, and accountability in LGU planning environments.

In contrast, compatibility, reliability and maintainability obtained the lowest overall mean score of 3.75, although it was still verbally interpreted as Highly Compatible. This result suggests that while the framework effectively operates within shared digital environments and integrates with external services such as ArcGIS and GeoRiskPH datasets, there are minor opportunities to further enhance interoperability with additional systems or legacy platforms

used by some LGUs. This finding is consistent with earlier discussions, which noted that reliance on external GIS services and heterogeneous LGU IT infrastructures may present integration challenges that can be addressed through future system enhancements.

The remaining quality attributes functional suitability (3.83), usability (3.88), and portability (3.83) all received high mean scores, indicating a balanced and well-rounded system design. These results confirm that the framework effectively supports key suitability analysis tasks, is easy to learn and operate, performs reliably under normal conditions, and can be maintained, modified, and deployed across different environments with minimal effort. The strong maintainability and portability scores are directly aligned with the framework's modular architecture, separation of frontend and backend components, and cloud-based deployment strategy discussed in earlier sections.

According to ISO/IEC 25010:2011, achieving consistently high ratings across multiple software quality characteristics indicates a system that is reliable, adaptable, and user-centered. The evaluation results demonstrate that the Suitability Analysis Framework meets these criteria, reinforcing its role as a robust GIS-based decision support system rather than a replacement for the entire CLUP process.

IV. CONCLUSIONS

This study focused on the design, development, and evaluation of a Suitability Analysis Framework for strengthening Comprehensive Land Use Planning (CLUP) in Local Government Units (LGUs). Based on the findings, the following conclusions were drawn:

The Suitability Analysis Framework was successfully developed following the phases of the Agile Model, including defining requirements, system design, development, UI/UX enhancement, user acceptance testing, and deployment. The use of an iterative development approach enabled continuous refinement of system features, resulting in a structured, flexible, and responsive framework that effectively supports GIS-based suitability analysis aligned with CLUP requirements.

The evaluation conducted by IT experts confirmed that the framework meets the ISO/IEC 25010 software quality standards. The system achieved high ratings across all quality characteristics functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability indicating that it is technically sound, reliable, and suitable for deployment in LGU planning environments.

The assessment conducted by end-users, including LGU planners and technical staff, demonstrated that the framework performs effectively in terms of functional suitability, performance efficiency, and usability. The system supports planning workflows, improves the interpretation of spatial data, and enhances the overall efficiency of suitability analysis in CLUP preparation.

The overall acceptability of the Suitability Analysis Framework was rated as acceptable to highly acceptable by end-users. The framework was found to be effective in improving user experience, data visualization, and decision-making processes. Furthermore, its use of existing GeoRiskPH datasets and standard GIS tools makes it a cost-efficient and practical solution for strengthening the suitability analysis component of CLUP in LGUs.

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