

Development of a Village Potential Mapping System for Pulorejo Village, Dawarblandong District, Mojokerto Regency, to Support Village Development Planning

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ABSTRACT

Villages, as the smallest administrative units of government, play a crucial role in supporting sustainable development through the optimization of local resources and potentials. However, the lack of integrated spatial data often hinders evidence-based village development planning. This study aims to analyze the implementation and outcomes of developing a Geographic Information System (GIS)-based village potential map for Pulorejo Village as an information system to support village development planning toward becoming an independent village. The research employed a descriptive spatial approach using GIS technology and ArcGIS software. The methodology consisted of secondary data collection, field surveys to obtain primary data in the form of geographic coordinates of village potentials, spatial data processing through digitization and overlay techniques, and participatory validation involving village officials. The results indicate that the resulting village potential map provides systematic and integrated information on administrative boundaries, the distribution of micro, small, and medium enterprises

(MSMEs), public facilities, and road networks. Spatial analysis revealed that community economic activities tend to concentrate in areas with higher accessibility, particularly along major roads and in locations adjacent to public facilities. The GIS-based map proved to provide more comprehensive information than conventional descriptive data and effectively supports more objective priority setting in village development planning. Therefore, the GIS-based village potential map can serve as a decision-support information system for village development planning and represents an initial step toward the development of a digital village information system within the smart village framework.

INTRODUCTION

Villages, as the smallest administrative units of government, play a crucial role in achieving sustainable development in Indonesia, particularly through the effective management of local resources and potentials. Village potential encompasses natural resources, human resources, economic activities, as well as social and cultural assets that, when managed optimally, can significantly improve community welfare. However, many villages still lack integrated and accurate spatial data describing their territorial potential, which limits the effectiveness of evidence-based development planning (Yuliyanto et al., 2022).

The rapid advancement of Geographic Information Systems (GIS) has created new opportunities for systematically mapping village potential in a more visual, comprehensive, and informative manner. GIS enables the integration of spatial and attribute data, facilitating the inventory, analysis, and visualization of information related to village resources and development assets (Allo La'bi et al., 2021). Among the available GIS platforms, ArcGIS has been widely recognized as an effective tool due to its advanced spatial analysis capabilities and its ability to produce thematic maps that support regional and village development planning.

GIS-based village potential mapping serves not only as a visualization tool but also as a decision-support system for village development planning. Previous studies have demonstrated that the availability of village potential maps improves the accuracy of development program targeting, enhances information transparency, and encourages greater community participation in the planning process. By integrating various spatial datasets, GIS enables local governments to identify development priorities more objectively and allocate resources more efficiently. Stakeholder participation is another essential component in producing reliable spatial information. The active involvement of village officials and local communities during the mapping process facilitates the identification of local potentials based on field conditions while fostering a sense of ownership of the resulting spatial database. Participatory discussions with village stakeholders, combined with field surveys of business locations, public facilities, and infrastructure, provide an effective mechanism for validating spatial information and ensuring data accuracy.

The increasing availability of digital spatial resources has further enhanced the efficiency of village mapping activities. Secondary data sources, such as Google Maps, can be integrated with primary data collected through field surveys to enrich spatial information and improve the completeness and accuracy of village potential maps. The integration of online geospatial information with field observations allows for more comprehensive documentation of village assets and infrastructure. Pulorejo Village possesses considerable local potential, particularly in community-based enterprises and supporting public facilities. Nevertheless, these resources have not yet been systematically documented within an integrated spatial database. The absence of a comprehensive village potential map limits effective development planning and local economic development initiatives. Therefore, this study implements the development of a GIS-based village potential map using ArcGIS through a participatory approach involving village stakeholders, field surveys, and digital spatial data integration to support evidence-based village development planning (Yuliyanto et al., 2022). In addition to mapping village potential, the preparation of a

spatially referenced administrative map contributes to more organized and effective village development planning. Standardized administrative maps provide important references for infrastructure planning, boundary management, and village resource inventory (Maliki et al., 2025). Furthermore, participatory administrative mapping improves data accuracy by involving local communities directly in identifying administrative boundaries and public facilities.

The application of GIS in thematic mapping enables the systematic integration of diverse spatial information, including administrative boundaries, land use, transportation networks, public infrastructure, and the spatial distribution of economic activities. Such thematic maps provide informative spatial visualizations and facilitate comprehensive territorial analysis for development planning purposes (Saily et al., 2021). The integration of spatial and attribute data enables village authorities to identify priority development areas and strategically allocate development resources. Beyond its technical advantages, participatory GIS-based thematic mapping also serves as an instrument for community empowerment. The involvement of village officials and community members in data collection and validation improves the quality and sustainability of the spatial database while strengthening local ownership of development initiatives. As emphasized by Gaffara et al. (2024), participatory field surveys play a critical role in establishing sustainable spatial databases that can support long-term village planning, resource management, and territorial governance.

Overall, this study aims to analyze the implementation and outcomes of developing a GIS-based village potential map for Pulorejo Village as a decision-support information system for village development planning. The resulting spatial database is expected to provide a reliable foundation for evidence-based policymaking and serve as an initial step toward implementing a Smart Village framework through digital village information systems.

RESEARCH METHOD

This study aims to analyze the implementation process and outcomes of developing a Geographic Information System (GIS)-based village potential map as a decision-support information system for village development planning toward achieving an independent and sustainable village. The research procedure is illustrated in a flowchart consisting of five sequential stages. The process begins with the preparation stage, including the collection of secondary data and coordination with village officials. The second stage involves the identification of village potential through participatory discussions with key stakeholders. The third stage consists of field surveys to collect spatial data and geographic coordinates of village resources and infrastructure. Subsequently, the collected data are processed using ArcGIS to produce thematic maps. Finally, the resulting maps are validated jointly with village officials before being finalized as both digital and printed village potential maps.

This study employed a descriptive spatial research approach based on Geographic Information Systems (GIS) using ArcGIS software to map the development potential of Pulorejo Village. The research methodology follows the GIS-based village mapping framework proposed by Saputra et al. (2025), which consists of four principal stages: preparation, data collection, spatial

data processing, and map validation. This approach was selected because it enables the systematic integration of spatial and non-spatial information, thereby producing reliable geographic information to support evidence-based village development planning. A participatory research approach was adopted by actively involving village officials as key stakeholders throughout the mapping process. Initial discussions and semi-structured interviews were conducted to identify administrative boundaries, community business locations, public facilities, transportation networks, and other local development potentials. This participatory approach is consistent with the concept of participatory village mapping, which positions local communities and village governments as active contributors to territorial planning and development (Handoko et al., 2021). In addition, collaborative validation with village officials was conducted to ensure the accuracy and reliability of the generated spatial information (Abdillah & Suleha, 2025).

The research began with the collection of secondary data, including administrative boundary maps, official village boundary information, and satellite imagery obtained from Google Maps. These datasets served as the initial reference for planning field surveys and determining the locations of village potential to be mapped. Subsequently, primary data were collected through field observations by visiting community businesses, public facilities, and other strategic locations identified during stakeholder consultations. During the field survey, direct observations were conducted, and geographic coordinates were recorded using GPS devices and the coordinate features available in Google Maps. The collection of spatial coordinates and photographic documentation followed GIS-based spatial mapping procedures emphasizing positional accuracy and field verification (Saputra et al., 2025).

The collected spatial data were processed using ArcGIS through several stages, including coordinate data input, administrative boundary digitization, thematic layer creation, and cartographic design involving symbols, legends, and map layouts. The digitization process transformed field observations into standardized digital spatial datasets that could be integrated with satellite imagery. Spatial overlay and data integration techniques were subsequently applied to improve positional consistency and enhance the completeness of the village potential database. These procedures follow established GIS methodologies for developing administrative and thematic village maps (Abdillah & Suleha, 2025).

The final stage consisted of map validation and presentation. Validation was carried out collaboratively with village officials to verify that the spatial information accurately represented actual field conditions. This participatory validation process enhances both the technical accuracy and social legitimacy of the resulting maps, ensuring their suitability as decision-support tools for participatory village development planning (Handoko et al., 2021). The final outputs of this research comprise both digital and printed GIS-based village potential maps, which are expected to function as a spatial information system supporting development planning, decision-making, and the optimization of local resources toward the realization of an independent Smart Village.

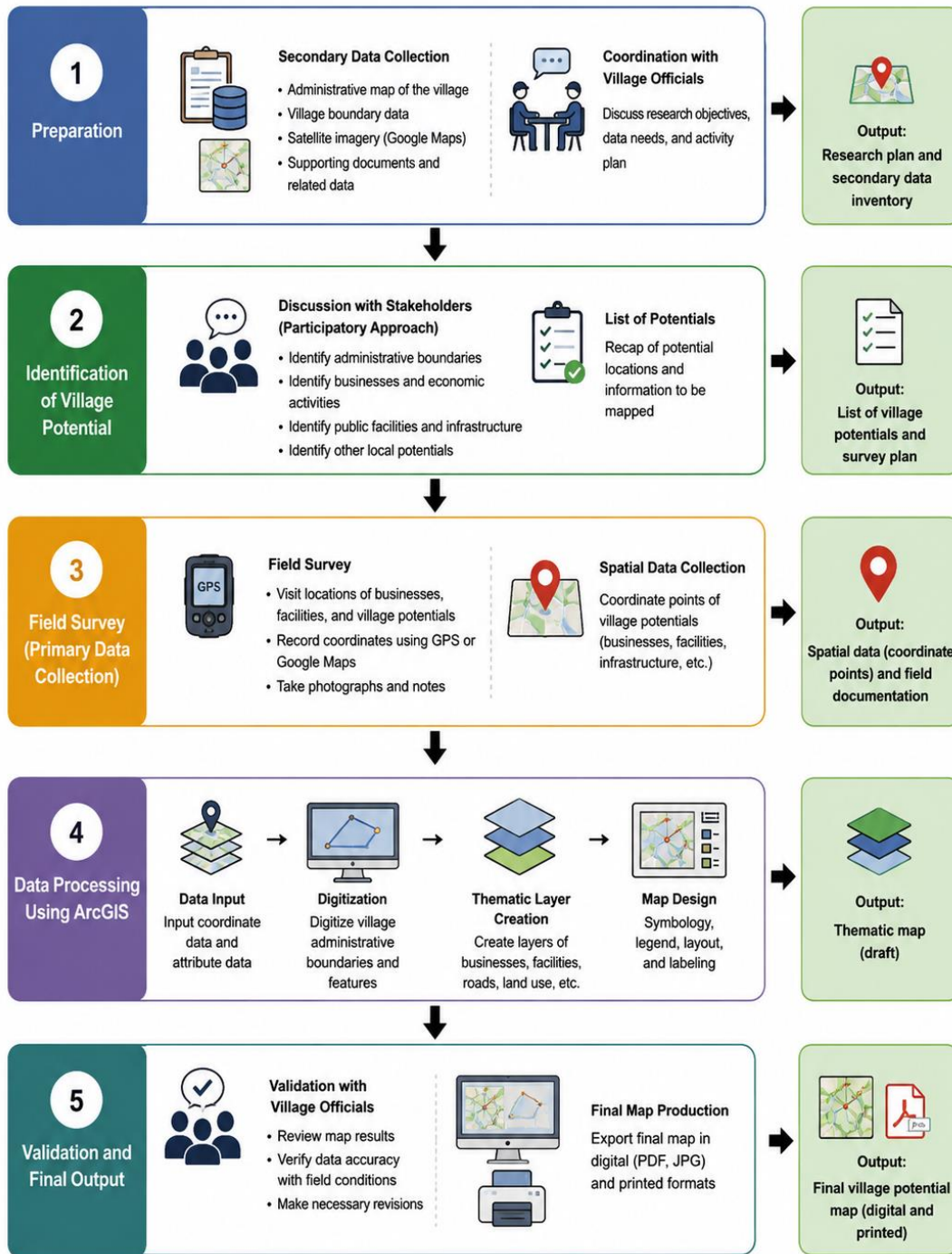


Figure 1. presents the overall research framework employed in this study, illustrating the sequence of activities from data preparation to the production of the final village potential map.

RESULTS AND DISCUSSION

The implementation of GIS-based village potential mapping in Pulorejo Village resulted in a comprehensive thematic map containing spatial information on administrative boundaries, the distribution of Micro, Small, and Medium Enterprises (MSMEs), public facilities, road networks, and village boundaries. The spatial database was developed using ArcGIS through several processing stages, including data digitization, attribute data input, spatial overlay, and cartographic layout design. The final map was produced in both digital and printed formats to support village administration and development planning.

The spatial distribution of village potential indicates that most economic activities, particularly MSMEs, are concentrated along the village's primary transportation corridors. This pattern demonstrates a strong relationship between accessibility and local economic development. Areas with better road connectivity provide greater opportunities for commercial activities, market accessibility, and service provision. These findings are consistent with previous studies emphasizing that road accessibility and public infrastructure constitute important parameters in spatial suitability analysis using GIS (Fauzi & Apriani, 2022). Furthermore, the thematic map illustrates the distribution of public facilities, including educational institutions, government offices, and other public service infrastructures, providing an overview of the spatial equity of public services across the village.

The results demonstrate that GIS-based village potential mapping provides more systematic, integrated, and informative data than conventional descriptive information. Unlike textual records, spatial data enable the analysis of geographical relationships among different village assets, facilitate the identification of economic clusters, and support the evaluation of public facility distribution. Prior to this study, the absence of an integrated spatial database in Pulorejo Village limited the implementation of evidence-based development planning. The developed GIS database now provides village authorities with both visual and analytical tools for identifying development priorities and optimizing resource allocation.

The application of ArcGIS enabled the integration of multiple thematic layers through spatial overlay analysis, including administrative boundaries, MSME locations, public facilities, and transportation networks. This overlay approach follows the methodology described by Fauzi and Apriani (2022), who demonstrated that combining multiple spatial parameters produces more accurate information for regional planning. The spatial analysis revealed that economic activities are predominantly concentrated in areas characterized by higher accessibility and close proximity to public facilities. These findings indicate a positive relationship between infrastructure development and local economic growth, suggesting that future infrastructure investments could stimulate further economic expansion in strategically accessible areas.

Beyond functioning as a thematic map, the resulting GIS database has the potential to serve as the foundation for a digital village information system. Such integration aligns with the Smart Village concept, which emphasizes the use of digital technologies to improve governance, public services, and community participation. According to Achmad Choirun N.W. et al. (2025), the implementation of digital village information systems enhances administrative efficiency,

promotes transparency, and improves the quality of public services through centralized spatial information management.

In the context of Pulorejo Village, the GIS-based village potential map can therefore become the core spatial database for future digital governance initiatives. By integrating spatial information into a village information system, village administrators would be able to update development data continuously, monitor infrastructure expansion, identify investment opportunities, and disseminate spatial information more effectively to stakeholders and local communities. Such a system would also support participatory planning by enabling evidence-based decision-making and increasing public access to development information.

Overall, the findings indicate that GIS-based village potential mapping significantly improves the quality and accessibility of spatial information for village development planning. The integration of spatial analysis facilitates the identification of economic activity patterns, evaluates the distribution of public facilities, and supports objective prioritization of development programs. Consequently, the developed village potential map represents not only a cartographic product but also an important decision-support tool that can be further expanded into a comprehensive GIS-based Smart Village Information System, thereby contributing to sustainable and data-driven rural development.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the research findings and discussion, it can be concluded that the development of a Geographic Information System (GIS)-based village potential map using ArcGIS successfully produced systematic, integrated, and informative spatial data for Pulorejo Village. The resulting thematic map incorporates administrative boundaries, the spatial distribution of Micro, Small, and Medium Enterprises (MSMEs), public facilities, and road networks, providing a reliable spatial database to support evidence-based village development planning.

The spatial analysis revealed that community economic activities are predominantly concentrated in areas with high accessibility, particularly along the village's primary road network and in locations adjacent to public facilities. These findings indicate a strong relationship between infrastructure availability and local economic development. By integrating spatial and attribute data within a GIS environment, village authorities gain a more comprehensive understanding of the spatial distribution of local resources and development potential.

Furthermore, GIS-based mapping proved to be more effective than conventional descriptive data in supporting spatial analysis, identifying relationships among territorial components, and facilitating objective prioritization of development programs. The participatory approach adopted in this study, involving village officials throughout the identification and validation processes, significantly improved data accuracy while enhancing the credibility and legitimacy of the resulting maps. Consequently, the developed village potential map functions not only as a spatial visualization tool but also as a decision-support information system that represents

an important first step toward implementing a Smart Village through digital village information systems.

Recommendations

To maximize the benefits of the developed GIS database, the government of Pulorejo Village should conduct periodic updates of spatial data to ensure that the village potential map remains consistent with ongoing territorial development and socioeconomic changes. Continuous data updating is essential for maintaining the relevance and reliability of spatial information used in development planning.

The village potential map should also be further developed into a web-based GIS platform or digital village information system, allowing spatial information to be accessed more efficiently, transparently, and interactively by government officials, stakeholders, and the wider community. Such digital integration would strengthen village governance while supporting the implementation of Smart Village initiatives.

In addition, capacity-building programs should be provided for village officials to improve their competencies in GIS operation, spatial data management, and digital mapping. Enhancing local technical capacity would enable the village administration to independently maintain and update spatial databases, ensuring the long-term sustainability of the information system. Future research is encouraged to incorporate more advanced GIS analytical techniques, such as land suitability analysis, network analysis, accessibility modeling, and spatial multi-criteria evaluation, to support more strategic and comprehensive development planning. Furthermore, integrating village-level spatial databases with district and regency development information systems would improve policy coordination and facilitate the implementation of integrated, data-driven regional development planning.

Overall, the GIS-based village potential map developed for Pulorejo Village serves not only as a cartographic visualization of local resources but also as a strategic instrument for strengthening village governance and supporting sustainable rural development. By integrating field survey data, participatory stakeholder input, and digital spatial information, the developed GIS database provides an accurate, comprehensive, and reliable reference for future village development planning and represents a significant step toward realizing a data-driven Smart Village.

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