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GIS-Based Village Facility Mapping for Data-Driven Development Planning in Rural Indonesia

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ABSTRACT

Purpose: This study aims to document the design, implementation, and outcomes of a Geographic Information System (GIS)-based village facility data collection and mapping program conducted as part of the Community Service Program (KKN) community service program of Universitas Lampung at Gebang Hilir Village, Teluk Pandan District, Pesawaran Regency, Lampung Province, Indonesia.
Methodology: A qualitative case study approach was employed, integrating field observation, GPS-based coordinate collection, attribute data recording, and spatial data processing using ArcGIS software. The four-stage implementation followed a structured workflow: preparation, data collection, data processing, and reporting and handover to the village government.
Results: Village facilities that had previously remained undocumented in digital or spatial form were successfully inventoried and mapped into an accurate, informative, and accessible digital map. The resulting GIS map covering religious, educational, health, government, and economic facilities was produced and formally handed over to the Gebang Hilir village government, achieving a 90% program completion rate.
Conclusions: The GIS-based mapping program effectively addressed the village's critical spatial data deficit, producing a practical geospatial tool that supports village asset management, development planning, and community information services.
Limitations: The program was limited by time constraints, adverse weather during fieldwork, and the lack of a mechanism for continuous data updates.
Contributions: This study provides a replicable GIS-based community service model for village facility mapping in rural communities with limited spatial data infrastructure.

Keywords: *Community Service Program, Geographic Information System, Mapping, Spatial Data, Village Facilities*

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1. Introduction

Geographic Information Systems (GIS) have emerged as transformative instruments for managing spatial data across diverse governance and development contexts. In the rural village context of Indonesia, where decentralisation has transferred significant planning and resource allocation responsibilities to village governments under Law No. 6 of 2014 on Villages, the availability of accurate, accessible, and current spatial information constitutes a foundational prerequisite for evidence-based governance (Dwipayana, & Eko, 2003; Muta, 2015). Village governments that possess reliable digital maps of their facility infrastructure are better equipped to allocate resources equitably, identify service gaps, attract development investment, and engage community members in participatory planning processes. However, in a large proportion of Indonesian villages, particularly those in rural and semi-urban areas of Lampung Province, village facility data remains undocumented in digital formats, relying instead on informal knowledge, hand-drawn sketches, or outdated paper records that do not support systematic spatial analysis (Badan, 2021; Arsanjani, Barron, Bakillah, Hagenauer, & Zipf, 2015).

The development of national geospatial infrastructure in Indonesia, anchored by Law No. 4 of 2011 on Geospatial Information and the One Map Policy (Kebijakan Satu Peta), has established a policy framework prioritising the systematic documentation of spatial data at all administrative levels, including villages (Ramdani & Mori, 2015). Despite this framework, village-level implementation remains uneven. The Indonesian Village Fund (*Dana Desa*) program, which has channelled increasing resources to village governments since 2015, creates both the financial capacity and the administrative accountability requirement for villages to produce and maintain accurate data on their infrastructure assets. Yet many villages lack the technical capacity and tools to translate these requirements into practice (Sumarto, 2020; Yuniarto, 2018). This capacity gap represents a significant opportunity for university-based community service programs to contribute geospatial expertise and technical assistance that produces lasting improvements in village data management capability.

Gebang Hilir Village, located in Teluk Pandan District, Pesawaran Regency, Lampung Province, exemplifies this common pattern. The village encompasses an area of approximately 1,198.96 hectares, with a population of 6,598 residents distributed across 30 Neighbourhood Units (RT) and six Hamlets (*dusun*). The community's economy centres on agriculture, fisheries, trade, and micro and small enterprises, with emerging tourism potential in the coastal and natural environment areas of the district. Despite this scale and economic dynamism, the village possessed no systematic digital documentation of its facility locations prior to the present program. Public facilities including mosques, schools, health posts, the village office, and market infrastructure existed and functioned but were not recorded in any accessible spatial database or map that village officials could consult for planning purposes (Handoko & Tucunan, 2021).

The Community Service Program (KKN) program of Universitas Lampung provides a structured mechanism through which undergraduate students from multiple disciplines contribute to rural community development over a period of approximately one month. The KKN Period I 2026 program placed a nine-member interdisciplinary team at Gebang Hilir Village from 8 January to 8 February 2026. Within this team's work program, the GIS-based village facility data collection and mapping project was identified as a priority intervention in the Technology, Information, and Communication domain, responsive to the observed spatial data deficit. The program leveraged the GIS competencies of team members trained in Soil Science, Forestry, and related spatial disciplines to produce a digital facility map using ArcGIS software, supported by GPS-based field data collection (Longley, Goodchild, Maguire, & Rhind, 2015; Burrough, McDonnell, & Lloyd, 2015).

The potential benefits of GIS-based village mapping extend across multiple development planning functions. Accurate facility location data supports equitable distribution of services across hamlet clusters, enables evidence-based assessment of infrastructure coverage gaps, and provides the spatial foundation for targeted investment in underserved areas (Rushton, 2003; Malczewski, 1999).

GIS maps also serve as communication tools that make spatial information accessible to non-technical stakeholders including community members, enabling more inclusive and informed participation in village planning processes (Elwood, 2006; Sieber, 2006). In the context of Indonesia's village autonomy framework, these capabilities directly support the village government's mandate to formulate Medium-Term Village Development Plans (RPJMDes) and Annual Village Action Plans (RKPDes) on the basis of evidence about actual conditions in the village (Yuniarto, 2018).

The novelty of this study lies in its documentation of a complete GIS-based facility mapping cycle, from needs identification through to formal handover of a verified digital map to the village government, within the specific institutional context of the Indonesian KKN community service program. While GIS applications in rural development planning have been extensively studied at the national and regional level, peer-reviewed documentation of village-scale GIS mapping programs implemented through university community service frameworks remains limited in the Indonesian literature. This study addresses that gap by providing a detailed process account and outcome evaluation that can inform the design of comparable programs in other village contexts. The objectives of this study are to document the implementation process and technical methodology of the GIS-based village facility mapping program at Gebang Hilir; to evaluate the outcomes and quality of the digital map produced; and to assess the program's contribution to village data management capacity and development planning support.

2. Literature Review

2.1 Geographic Information Systems in Rural Development Planning

Geographic Information Systems provide an integrated environment for capturing, storing, managing, analysing, and visualising spatially referenced data, enabling users to understand patterns, relationships, and processes in geographic space (Longley, Goodchild, Maguire, & Rhind, 2015; Burrough, McDonnell, & Lloyd, 2015). The application of GIS to rural development planning has been extensively studied across diverse national and development contexts, consistently demonstrating that spatial data availability improves the quality of planning decisions, the equity of resource allocation, and the effectiveness of service delivery monitoring (Malczewski, 1999; Rushton, 2003). At the village or local government level, GIS tools have been shown to enhance facility location analysis, infrastructure gap assessment, land use planning, and community consultation processes (Elwood, 2006; Sieber, 2006; Goodchild, 2007).

In the Indonesian context, the development of village-level GIS capacity has been progressively supported by national policy frameworks. The One Map Policy, formalised by Presidential Regulation No. 9 of 2016, mandates the integration of geospatial information across all levels of government and establishes the Badan Informasi Geospasial (BIG) as the coordinating authority for national spatial data infrastructure (Ramdani, & Mori, 2015; Setiawan, Koswara, & Withaningsih, 2023). At the village level, the Village Fund program's accountability requirements create incentives for village governments to develop and maintain accurate data on infrastructure assets, while the Village Information System (Sistem Informasi Desa) framework provides a digital platform for village data management (Yuniarto, 2018; Sumarto, 2020; Zhao, & Li, 2022). However, Muta (2015) demonstrates that the gap between policy intent and implementation reality at the village level remains substantial, with most villages in Lampung and comparable provinces lacking the technical capacity to produce or maintain GIS-quality spatial data independently.

Research on Participatory GIS (PGIS) in rural development contexts is particularly relevant to the community service framework of the present study. PGIS approaches integrate local knowledge with technical GIS tools to produce spatial data that is both geographically accurate and socially grounded in community understanding of place and facility use patterns (Sieber, 2006; Elwood, 2006). Corbett and Keller (2005) demonstrate that PGIS interventions in rural communities produce maps that are more accurate representations of actual facility locations and conditions than those produced through top-down expert-only approaches, because local informants correct errors that remote or office-based data collection cannot detect. The field observation and coordination methodology employed in the present program, in which village officials were consulted throughout

the data collection and verification process, reflects participatory GIS principles and contributes to the map's accuracy and institutional legitimacy.

Handoko and Tucunan (2021) provide the most directly comparable Indonesian case study, documenting a participatory village mapping program at Ngepung Village, Nganjuk Regency, East Java, using a comparable four-stage methodology of preparation, data collection, processing, and reporting. Their findings demonstrate that participatory mapping produces accurate, institutionally supported spatial products that village governments actively use for development planning, consistent with the outcomes documented in the present study. Arsanjani, Barron, Bakillah, Hagenauer, and Zipf (2015) further demonstrate that community-contributed geographic data, while varying in precision, provides a highly cost-effective foundation for village-level facility mapping that can subsequently be refined through targeted GPS verification, precisely the approach adopted in the present program.

2.2 GPS-Based Data Collection and ArcGIS Processing for Village Mapping

The Global Positioning System provides the foundational data collection technology for GIS-based facility mapping, enabling precise geographic coordinate recording in field conditions without requiring fixed survey infrastructure (Kaplan & Hegarty, 2006). Modern handheld GPS devices achieve horizontal position accuracy of three to five metres under open sky conditions, which is sufficient for village facility mapping where the primary purpose is spatial distribution analysis rather than cadastral-precision boundary demarcation (Van & Enge, 2015). The combination of GPS coordinate collection with systematic attribute data recording, including facility name, type, operational status, and physical condition, produces the comprehensive point dataset needed to generate informative GIS maps (Longley, Goodchild, Maguire, & Rhind, 2015).

ArcGIS, developed by ESRI (2023), is the most widely deployed professional GIS software platform globally, providing comprehensive tools for spatial data management, analysis, and cartographic production (ESRI, 2023). Its use in university-affiliated community service projects is well-established in Indonesian academic practice, with studies by Handoko and Tucunan (2021), Ramdani and Mori (2015), and multiple comparable programs documenting successful village map production using ArcGIS within comparable resource and time constraints. The software's map layout tools enable production of publication-quality cartographic outputs with standard map elements including north arrow, scale bar, legend, coordinate grid, and data source attribution, producing a map that meets professional standards for official document use by village governments (Bolstad, 2019).

The integration of field GPS data with village administrative boundary data from national topographic databases enables the production of contextualized facility location maps that situate individual facilities within the larger spatial context of hamlet boundaries, road networks, and hydrological features (Muta, 2015). This contextualization is critical for planning utility because it enables village officials to assess the spatial relationship between facility locations and population distribution, road accessibility, and topographic constraints on service access. Kurniawan, Adrianto, Bengen, and Prasetyo (2019) demonstrate that village facility maps produced using this integrated approach are consistently rated by village officials as more useful for planning purposes than facility lists or non-spatial inventories because the map format enables immediate visual comprehension of spatial patterns that textual data cannot convey.

2.3 KKN Community Service Programs as Vehicles for Technical Capacity Transfer

The Kuliah Kerja Nyata program represents a distinctive institutional mechanism for university knowledge transfer to rural communities, combining the practical learning objectives of experiential education with the community development objectives of public service engagement (Farman et al., 2021; Arifin, 2017). Research on KKN program outcomes consistently demonstrates that technically focused programs, in which students apply discipline-specific expertise to address identified community needs, produce more durable and utilised outputs than general-purpose programs lacking technical specialisation (Yuniarto, 2018; Rosyad and Muthohirin, 2021). GIS-based mapping projects represent a particularly effective vehicle for KKN technical contribution

because they produce a tangible, institutionally valuable output, the digital village map, that continues to serve village planning needs beyond the program duration.

Rosyad and Muthohirin (2021) document a comparable KKN-based village mapping program in West Java, finding that villages receiving digitally mapped facility data demonstrated measurably improved integration of spatial evidence in subsequent village development planning cycles. Farman et al. (2021) demonstrate that the participatory approach characteristic of KKN programs, in which students coordinate closely with village officials and community members throughout implementation, enhances both the technical quality and the community ownership of program outputs, increasing the likelihood that maps and databases will be actively used and maintained after the program's conclusion. These findings align with broader evidence from the community development literature that participatory co-production of spatial data produces more institutionally embedded and utilised outcomes than expert-only technical interventions (Sieber, 2006; Elwood, 2006).

The interdisciplinary composition of KKN teams provides a structural advantage for GIS mapping programs, as the combination of students from GIS-competent disciplines (Soil Science, Forestry, Agriculture) with students from social disciplines (Sociology, International Relations, Law) enables simultaneous technical data collection and community engagement activities. Arifin (2017) argues that this interdisciplinary structure is a distinctive strength of the KKN model relative to single-discipline consulting interventions, producing programs that address both the technical and social dimensions of community development challenges simultaneously. The present program exemplifies this strength, with GIS-trained team members leading the technical mapping work while social science and law students contributed to community engagement and village official coordination activities.

2.4 Digital Village Data Management and Development Planning

The transition from manual to digital village data management represents a significant improvement in the quality and utility of information available to village governments for planning and governance purposes. Sumarto (2020) demonstrates that villages with access to digital facility databases and spatial maps make more equitable and evidence-based decisions in village fund allocation compared to villages relying on informal or non-spatial data. The Village Information System (SID) framework established by the Ministry of Village, Disadvantaged Regions, and Transmigration provides a national digital platform for village data management, but its utility depends on the quality and completeness of the spatial data available to populate it (Yuniarto, 2018; Hidayat, & Setiawan, 2020).

Goodchild (2007) argues that the democratisation of geospatial tools, including the widespread availability of GPS devices and open-source GIS software, has created unprecedented opportunities for rural communities to produce and own their own spatial data, shifting the locus of geographic knowledge production from centralised expert institutions to local communities and their partners. In the Indonesian village context, this democratisation is manifest in the growing number of KKN and similar community service programs that deliver GIS technical assistance to villages that would not otherwise have access to professional mapping expertise. The present study contributes to this trend by documenting a successful GIS-based facility mapping program that required only equipment and software accessible at the university level, making it replicable by comparable community service programs elsewhere (Pratama & Sari, 2022).

3. Methodology

This study employed a qualitative case study research design to document and evaluate the GIS-based village facility data collection and mapping program implemented at Gebang Hilir Village, Teluk Pandan District, Pesawaran Regency, Lampung Province, during the Universitas Lampung KKN Period I 2026 (8 January to 8 February 2026) (Yin, 2018; Creswell and Poth, 2018). The case study design was selected because the program constituted a bounded, context-specific intervention with clearly identifiable inputs, processes, and outputs amenable to systematic documentation and evaluation. The research population comprised all nine KKN team members, the Gebang Hilir village government officials who participated in program coordination and data verification, and the

full set of village facilities targeted for mapping. Data collection for research documentation drew on four complementary sources: field observation records maintained throughout the program implementation period; GPS coordinate and attribute data collected during field data collection; ArcGIS processing documentation including layer files, attribute tables, and map layout files; and qualitative records of coordination meetings, field verification sessions, and the formal map handover event. The nine-member KKN team was drawn from diverse academic disciplines as presented in Table 1, providing complementary competencies in GIS data collection, spatial data processing, community coordination, and documentation.

Table 1. KKN team composition, Universitas Lampung period I 2026 at Gebang Hilir Village

No.	Name	Student ID	Department
1	Niken Purwanti	2314131079	Agribusiness
2	Rindu Salsabil Nabilah	2215041113	Chemical Engineering
3	Vivian Fortuna Ramadani	2316071107	International Relations
4	Nandito Bramantio	2312011136	Law
5	Gusti Made Arsana	2311011068	Management
6	Mearly Ross Dehta	2314181054	Soil Science
7	Farhan Alfarizy	2314151110	Forestry
8	M. Hibban Fadlurrohman A.	2314231014	Agricultural Product Technology
9	Diana Chandra Olivia	2316011121	Sociology

Table 1 shows the nine-member interdisciplinary composition of the KKN team deployed at Gebang Hilir Village. The team's diversity across disciplines, including Soil Science, Forestry, Chemical Engineering, International Relations, Law, Management, Agricultural Product Technology, and Sociology, provided complementary competencies that supported the integrated program approach. The GIS-relevant technical expertise contributed by students from Soil Science and Forestry was embedded within a broader interdisciplinary team structure, enabling simultaneous technical data collection and community engagement activities consistent with the participatory methodology recommended by Farman et al. (2021) and Sieber (2006).

The GIS-based facility mapping program followed a four-stage implementation framework comprising preparation, data collection, data processing, and reporting and handover, as detailed in Table 2. The preparation stage involved a pre-program field survey of Gebang Hilir Village, coordination meetings with the village head (Kepala Desa) and hamlet heads (Kepala Dusun), and the development of a structured facility identification checklist covering religious, educational, health, government, and economic facility categories. The data collection stage employed handheld GPS devices to record the geographic coordinates of each identified facility, supplemented by systematic attribute data recording including facility name, category, operational status, and physical condition assessment. Field photography documented each facility's physical appearance and spatial context. The data processing stage involved compiling the GPS coordinate and attribute data into an ArcGIS geodatabase, creating point feature layers for each facility category, applying cartographic symbology to differentiate facility types, and producing a final map layout incorporating all required cartographic elements. The reporting and handover stage included field verification of map accuracy in coordination with village officials, final corrections to the spatial database, production of a printed map poster in A0 format, and formal handover of both the printed map and digital GIS files to the Gebang Hilir village government.

Table 2. GIS-based facility mapping implementation stages

Phase	Stage	Activities	Output
1	Preparation	Field survey; coordination with village government; preparation of data collection instruments; identification of target facilities	Field survey report; facility checklist; coordination documentation
2	Data Collection	GPS-based coordinate recording of each facility; attribute data collection (facility name, type, condition); field photography and documentation	GPS coordinate dataset; facility attribute database; field documentation
3	Data Processing	Spatial database compilation in ArcGIS; point layer creation; symbology design; map layout and cartographic production	Digital GIS map of village facilities; printable map poster format
4	Reporting and Handover	Field verification of map accuracy with village officials; final map correction; printed map handover to village government; digital file transfer	Verified digital village facility map; printed poster; digital archive file handed to village government

Table 2 presents the four-stage implementation framework of the GIS-based facility mapping program, detailing the specific activities and outputs of each stage. The progression from preparation through data collection, processing, and formal handover reflects a structured workflow consistent with professional GIS project management practice as described by Longley et al. (2015) and Bolstad (2019). The stage produced distinct, verifiable outputs that contributed to the cumulative program outcome: a verified digital village facility map formally transferred to the Gebang Hilir village government. The formal handover stage, which distinguished this program from many comparable academic mapping exercises that produce maps solely for research purposes, was critical for ensuring the map's integration into village governance processes.

4. Results and Discussion

4.1 Result

The GIS-based village facility data collection and mapping program at Gebang Hilir Village was successfully implemented across all four stages, producing a comprehensive digital map of village facilities that was formally presented and handed over to the village government. The program achieved an overall completion rate of 90 percent relative to the initial facility identification target, with the remaining 10 percent attributable to access limitations in remote hamlet areas during adverse weather conditions. Table 3 presents the initial conditions, interventions, and outcomes achieved across the four key program dimensions assessed.

Table 3. Initial conditions, interventions, and achieved outcomes by program dimension

Aspect	Initial Condition	Intervention	Expected Outcome
Village Data Availability	Village facility data had not been systematically collected or documented digitally by the KKN team.	Field observation, interviews with village officials, and secondary data collection.	A structured village dataset compiled as a foundation for program planning.
Village Potential Identification	The economic, social, educational, and environmental potentials of the village had not been comprehensively mapped.	Systematic data collection covering economic, social, educational, and environmental dimensions.	Village potentials identified and documented for planning reference.

Aspect	Initial Condition	Intervention	Expected Outcome
Facility Location Information	The precise locations of village facilities and public services were unknown or not recorded in accessible form.	GPS-based coordinate collection and GIS mapping of all identified facilities.	Accurate digital locations of program sites and village facilities determined.
Development Program Planning	Work programs had not been formulated based on systematic community needs assessment.	Analysis of data collection and mapping results to identify priority intervention areas.	Work programs designed in alignment with actual village conditions and community needs.

Table 3 shows the transformation achieved across four dimensions of village spatial data management through the program's systematic intervention. Four targeted dimensions moved from conditions of data deficit and informal knowledge management to documented, structured, and accessible digital information. The most significant transformation was achieved in the Facility Location Information dimension, where the complete absence of spatial documentation was replaced by a GPS-verified digital database and GIS map covering all identified facility categories. The Development Program Planning dimension outcome illustrates the upstream benefit of the mapping program: by providing the KKN team itself with accurate spatial knowledge of the village's facility distribution, the mapping program directly enabled better-targeted and more equitably distributed community service activities in other program domains during the same KKN period.

The field data collection phase successfully recorded GPS coordinates and attribute data for village facilities across five primary categories: religious facilities (mosques and prayer halls distributed across all six hamlets), educational facilities (elementary and secondary schools), health facilities, government and administrative facilities (village office, hamlet administrative posts, and community halls), and economic and market facilities (traditional market, cooperative office, and agricultural collection points). Table 4 presents the facility categories mapped, the types of facilities documented within each category, and their significance for village development planning.

Table 4. Village facility categories mapped, types documented, and planning significance

Facility Category	Types Documented	Significance for Village Development Planning
Religious Facilities	Mosques (Masjid), prayer halls (musholla) distributed across six hamlets (dusun)	Community assembly and social cohesion hub; proximity indicators for community service program placement
Educational Facilities	Elementary schools (SDN), junior secondary schools, informal education centres	Education access gap analysis; basis for educational community service program targeting
Health Facilities	Village health post (Posyandu), community health centre outpost (Puskesmas Pembantu)	Healthcare access mapping; identification of underserved hamlet clusters
Government and Administrative Facilities	Village office (Kantor Desa), hamlet administrative posts, community hall (Balai Dusun)	Administrative service accessibility; community meeting infrastructure inventory
Economic and Market Facilities	Traditional market, cooperative office, agricultural product collection points	Economic activity spatial pattern analysis; market access equity assessment

Table 4 shows the five facility categories documented through the GIS mapping program, the specific facility types recorded within each category, and their respective significance for village development planning applications. Table 4 demonstrates that the mapped dataset covers all major dimensions of village public infrastructure, from community religious and social spaces through educational, health, administrative, and economic facilities. The planning significance column illustrates how each facility category's spatial data serves specific planning analysis functions, from service coverage gap assessment to market access equity evaluation. This multi-category coverage distinguishes the present program from narrower facility-specific mapping exercises and produces a spatial dataset of comprehensive utility for the full range of village government planning needs.

The ArcGIS data processing phase produced a digital village facility map incorporating point feature layers for each facility category, differentiated by category-specific symbols and colour coding to enable rapid visual distinction of facility types. The map layout incorporated all standard cartographic elements including a north arrow, scale bar, coordinate grid, legend identifying all facility symbols, data source and production attribution, and the Universitas Lampung KKN team attribution. The final map was produced in A0 poster format for display at the village office and as a digital GIS file archive for ongoing use and updating. The program culminated in a formal map handover event at which the printed map poster and digital files were presented to the Gebang Hilir village head and key village officials.

Figure 1. Map Handover to Gebang Hilir Village Government Representative (February 2026)

Figure 1 shows a KKN team member presenting the completed village facility map to a Gebang Hilir village government representative at the map handover event. The large-format printed map poster is clearly visible, displaying the GIS-produced spatial distribution of village facilities across the village territory. The formal institutional character of the map handover, which distinguished the present program from academic-only mapping exercises by explicitly transferring ownership and custody of the spatial data product to the village government. This handover mechanism is consistent with recommendations from Farman et al. (2021) and Rosyad and Muthohirin (2021) that community service program outputs should be formally institutionalized through structured handover protocols to maximize the probability of post-program utilization.

Figure 2. KKN Team and Village Officials with Completed Facility Map (February 2026)

Figure 2 presents the complete nine-member KKN team gathered with village officials in front of the finished GIS-based village facility map poster at the conclusion of the program. The group photograph documents the full interdisciplinary team that contributed to the mapping program and related village development activities, illustrating the collaborative and team-based character of the KKN community service model. Figure 2 also captures the institutional context of the map handover, conducted at the village government premises with the large-format map prominently displayed, signifying the integration of the spatial data product into the village's official information environment. The image confirms the successful completion of all four program stages and the formal institutional embedding of the map within the Gebang Hilir village governance infrastructure.

4.2 Discussion

The outcomes of the GIS-based village facility mapping program at Gebang Hilir Village confirm the effectiveness of combining GPS-based field data collection with ArcGIS processing within the institutional framework of the KKN community service program, as a practical and replicable approach to addressing the spatial data deficit characteristic of rural villages in Lampung Province and comparable regions of Indonesia. The program's 90 percent completion rate, achieved within a single-month implementation period with a nine-member student team, demonstrates the feasibility of village-scale GIS mapping within KKN resource and time constraints, consistent with findings from Handoko and Tucunan (2021) in the East Java context.

The digital facility map produced by the program addresses a critical gap in Gebang Hilir Village's planning information infrastructure. Prior to the program, village officials possessed no systematic spatial record of facility locations, making it impossible to conduct proximity analysis, service coverage assessment, or evidence-based facility distribution evaluation using map-based methods. The GPS-verified facility dataset and ArcGIS-produced map now provide the village government with a spatial foundation for all these planning functions (Malczewski, 1999; Rushton, 2003). The multi-category coverage of the map, spanning religious, educational, health, government, and economic facilities as documented in Table 4, ensures that a single spatial product serves multiple planning domains rather than requiring separate mapping exercises for each facility category. This integration of multiple facility categories within a single GIS database is consistent with best-practice recommendations for village spatial data management (Bolstad, 2019).

The program's most significant institutional contribution beyond the technical map product was the formal handover of digital GIS files to the village government, documented in Figures 1 and 2. This handover ensures that the village possesses not only a printed map poster but also the underlying digital spatial database in a format that can be updated, extended, and used as the foundation for future GIS analysis. Rosyad and Muthohirin (2021) identify this distinction between program

outputs that remain with the implementing team and those formally transferred to community ownership as a critical determinant of long-term program impact. By transferring digital files alongside the printed map, the present program maximised the potential for sustained use of the spatial data beyond the KKN period.

The challenges encountered during implementation, including weather-related access limitations, time constraints on comprehensive facility coverage, and the need for field verification of initial data, are consistent with those documented in comparable village mapping programs (Handoko and Tucunan, 2021; Arsanjani, Barron, Bakillah, Hagenauer, & Zipf, 2015). The field verification component, conducted in coordination with village officials who identified corrections and additions to the initial dataset, reflects the participatory GIS principle that local knowledge is an essential complement to technical data collection for producing accurate and locally legitimate spatial products (Sieber, 2006; Corbett, & Keller, 2005). This participatory validation approach also contributed to village official engagement with and ownership of the resulting map, increasing the likelihood of its active use in subsequent planning processes.

The interdisciplinary team composition documented in Table 1 proved to be a genuine programmatic asset for the mapping program. The GIS-relevant technical expertise of students from Soil Science and Forestry provided the spatial data management and ArcGIS processing capabilities necessary for producing a professional-quality digital map. The complementary social, legal, and management competencies of other team members supported the community coordination, documentation, and institutional engagement activities that were equally important for the program's success. Arifin (2017) and Farman, Chairuddin, Herlina, Marniati, Hali, and Nasrum (2021) identify this interdisciplinary synergy as a structural advantage of the KKN model that single-discipline technical assistance programs cannot replicate. The present study provides empirical documentation of how this interdisciplinary structure operated in practice within a technically focused GIS mapping program.

The program's broader contribution to Gebang Hilir Village's development planning capacity extends beyond the immediate map product. The data collection process itself generated a comprehensive facility inventory that village officials reported using as a reference for the village's asset management database. The spatial visualisation of facility distribution revealed patterns that were not apparent from non-spatial facility lists, including the concentration of educational facilities in the western hamlets and the relative scarcity of health facilities in the eastern portions of the village territory. These spatial insights directly inform the priorities for future infrastructure investment that village officials can advocate for in district-level development planning consultations (Longley, Goodchild, Maguire, & Rhind, 2015; Goodchild, 2007). The program thus produced both an immediate tangible output and a longer-term contribution to evidence-based development planning capacity.

5. Conclusions

5.1 Conclusion

This study documented the design, implementation, and outcomes of a GIS-based village facility data collection and mapping program conducted at Gebang Hilir Village, Teluk Pandan District, Pesawaran Regency, Lampung Province, as part of the Universitas Lampung KKN Period I 2026 community service program. The program successfully addressed the village's pre-existing spatial data deficit by systematically collecting GPS-based coordinates and attribute data for village facilities across five categories, processing this data into a comprehensive digital GIS map using ArcGIS, and formally handing over both the printed map poster and digital GIS files to the village government. The program achieved a 90 percent completion rate relative to its initial facility coverage target, demonstrating that GIS-based village facility mapping is feasible within the resource and time constraints of the KKN institutional framework. The digital facility map produced represents a significant improvement over the informal, non-spatial facility knowledge that constituted the village's prior information state, providing a practical spatial tool that directly supports village asset management, development planning, service gap assessment, and community

information provision. The program's participatory implementation methodology, combining technical GPS and GIS expertise with active coordination with village officials throughout data collection and verification, produced a spatial product that is both geographically accurate and institutionally embedded in the village government's planning infrastructure.

5.2 Research Limitations

Four principal limitations of the present study are acknowledged. First, time constraints inherent in the one-month KKN program period prevented comprehensive coverage of all facility locations in the village, with approximately 10 percent of target facilities remaining unmapped due to access limitations and adverse weather. A longer or multi-phase program would produce more complete spatial coverage. Second, the study did not include a systematic mechanism for assessing the post-handover utilisation of the digital map by village government officials. While the formal handover was completed and village officials expressed positive intentions to use the map for planning, actual utilisation patterns were not monitored beyond the program period. Third, the GPS coordinate accuracy achieved with handheld consumer-grade GPS devices, while sufficient for facility location mapping, does not meet the precision requirements for cadastral applications such as land boundary demarcation. Future programs requiring higher precision should consider differential GPS or RTK-GPS equipment. Fourth, the ArcGIS-based digital files produced require ArcGIS software to open and edit, which may limit accessibility for village government staff who do not have access to this proprietary software. Future programs should consider producing outputs in open-source formats or developing simplified web-map alternatives accessible through standard browsers.

5.3 Directions and Future Study

Future research and program development should address the identified limitations and extend the present study's contributions in four directions. First, a longitudinal follow-up study assessing village government utilisation of the digital facility map at six and twelve months post-handover would provide evidence on the program's actual impact on village planning processes. Key indicators to assess include the map's use in RPJMDes and RKPDes document preparation, village fund allocation decisions referencing spatial facility distribution data, and the map's use in community consultation sessions. Second, future mapping programs should incorporate a capacity building component that trains selected village government staff in basic GIS data viewing and attribute updating using open-source GIS software such as QGIS, ensuring that the digital map remains current and accurate beyond the initial mapping exercise. This staff training component would transform the program from a one-time technical intervention into a sustained contribution to village GIS capacity.

Third, future programs should explore integration of the village facility map with the national Village Information System (Sistem Informasi Desa) platform, enabling the spatial data to contribute to and be accessible within the broader national village data infrastructure. This integration would extend the program's impact beyond the individual village level, contributing to the national One Map Policy objective of comprehensive village-level spatial data coverage. Fourth, a comparative study examining GIS-based mapping program outcomes across multiple villages with varying levels of pre-existing data capacity, geographic complexity, and village government technical engagement would provide evidence for identifying the contextual factors that most strongly determine program success, enabling more precisely targeted program design in future KKN-based mapping interventions. Future programs should also explore the potential of satellite imagery, drone-based aerial photography, and mobile GIS applications in reducing field data collection time while maintaining or improving coordinate accuracy, particularly for villages with difficult terrain or accessibility constraints.

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