

SUSTAINABLE RURAL INFRASTRUCTURE DEVELOPMENT: SOLAR STREET LIGHTING, CLEAN WATER PIPING, AND ASSET MAINTENANCE TRAINING

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ABSTRACT

Drawati Village, located in West Bandung Regency, possesses abundant natural springs yet faces persistent challenges in providing equitable access to clean water and adequate public street lighting. This community service program, implemented by the Civil Engineering Study Program of Universitas Mercu Buana, aimed to address these issues through a participatory engineering design approach. The program involved the construction of a spring-fed piping system with an integrated filtration unit for 15 previously underserved households, and the installation of five solar-powered public streetlights at strategic locations. Complementary capacity-building activities included training on basic electricity, community-based asset management, and the use of digital tools such as Google Forms and Google Drive for infrastructure monitoring. A volunteer maintenance team and a local business unit specializing in solar streetlight services were also established to ensure sustainability. Program effectiveness was evaluated through partner satisfaction surveys, technical performance testing, and qualitative interviews, yielding a Partner Satisfaction Index score of 88.29 (“Very Good”). The results demonstrate that integrating infrastructure provision with community empowerment, digital literacy, and institutional support can enhance both the functional reliability and the long-term sustainability of rural service systems.

Keywords: Community Service, Clean Water Access, Solar-powered Street Lighting, Community-based Asset Management, Rural Infrastructure Sustainability.

1. INTRODUCTION

Drawati Village, located in West Bandung Regency, is a highland area with abundant natural resource potential. The village has at least ten natural springs that serve as vital assets in supporting the community’s livelihood. However, this potential has not yet been fully optimized. Based on surveys and discussions with local government officials, it was found that several households still lack adequate access to clean water. This condition is consistent with data from the West Java Central Bureau of Statistics (Badan Pusat Statistik Jawa Barat, 2025), which recorded that the proportion of households with access to safe drinking water sources in West Bandung Regency was only 89.25%, lower than the provincial average of 94.90%. Efforts to meet this need have been made through various forms of assistance from government institutions and legislative members. Nevertheless, these efforts have not yet reached all residents, leaving a gap in access to clean water. Recent studies have also emphasized that challenges in rural water supply provision are often influenced by limited infrastructure and local management capacity (Bakari & Mbunda, 2022).

In addition to the clean water issue, Drawati Village also faces challenges related to the lack of public street lighting (PJU). The results of a Focus Group Discussion (FGD) with local government officials and the community organization *Masyarakat Peduli Lingkungan Desa Drawati* revealed that several areas remain without adequate street lighting. This condition raises particular concerns as it may decrease community safety and comfort, especially at night. The adoption of renewable energy, particularly solar power, has been proven to be an effective solution to increase lighting access in rural areas while also supporting energy sustainability (Goldsun Lights (2025).

In response to these issues, the Civil Engineering Study Program, Faculty of Engineering, Universitas Mercu Buana, initiated a Community Service Program (*Pengabdian kepada Masyarakat*, PkM) designed comprehensively to address the two main issues in Drawati Village—limited access to clean water and insufficient street lighting. The program includes the construction of a piping system along with the application of water filtration technology, targeting at least 15 households that previously lacked clean water access, as well as the installation of solar-powered streetlights at five strategic points in the village.

The program not only focuses on providing infrastructure but also emphasizes sustainability through community training and mentoring. Residents are engaged in capacity-building activities covering basic electricity knowledge, asset management for the water piping system, and maintenance of solar-powered streetlights. To ensure long-term benefits, an asset operator and management team has been established, comprising local government representatives and members of *Masyarakat Peduli Lingkungan Desa Drawati*. This approach aligns with research indicating that

community-based infrastructure management can enhance project sustainability and foster a stronger sense of ownership among residents (Rajouria et al., 2024). Accordingly, the program is expected not only to address immediate needs but also to foster community self-reliance in managing available resources and infrastructure.

2. METHOD

This community service project employed a participatory engineering design approach, integrating technical planning with active community involvement to ensure sustainability and local ownership. The implementation was structured into four main stages:

1. Site survey and data collection
2. Technical system design
3. Community engagement and system installation
4. Evaluation and performance testing

Based on the results of a Focus Group Discussion (FGD) with the village administration and the *Masyarakat Peduli Lingkungan* (Environmental Care Community Group) of Drawati Village—chaired by Asep Nanang Yahya—it was agreed that the main issues to be addressed in this program were:

1. Construction of a piping system from the water springs, equipped with a filtration unit, to distribute clean water to households without access to safe water.
2. Provision of solar-powered Public Street Lighting (PJU).
3. Formation of an asset management group to oversee the donated infrastructure, accompanied by training in asset management, maintenance, and repair.

Given the scope of the targets, the program was divided into six implementing teams, each led by a designated coordinator responsible for specific activities, as shown in Table 1.

Table 1. Activities and Responsibilities of Each Team Leader

Team Leader	Activity	Type
Dr. Acep Hidayat, S.T., M.T.	Construction of a Piping System to Meet the Clean Water Needs of Drawati Village Residents	Physical construction
Ika Sari Damayanthi Sebayang, S.T., M.T.	Application of Water Filtration Technology for Direct Consumption in Drawati Village	Physical construction
Dr. Raden Hendra Ariyapijati, S.T., M.T.	Utilization of Solar Power for Public Street Lighting (PJU) in Drawati Village	Physical construction
Reni Karno Kinasih, S.T., M.T.	Community Capacity Building on Basic Electricity and Solar-Powered PJU Installation	Training
Suprpti, S.T., M.T.	Community Capacity Building on Asset Management for Maintenance and Repair of Clean Water Pipelines	Training
Retna Kristiana, S.T., M.M., M.T.	Community Capacity Building on Asset Management for Maintenance and Repair of Public Street Lighting in Drawati Village	Training
Sediyanto, S.T., M.M.	Digital Transformation in Clean Water Asset Management: Training on Google Form-Based Data Recording for Drawati Village	Training

Methods for Physical Construction Activities

1. Conduct a survey of water springs and locations without lighting, followed by measurements, material planning, technical design, and preparation of the Cost Budget Plan.
2. Appoint workers and field supervisors, and determine the work start date.
3. Procure and transport materials to the site.
4. Execute the construction work in accordance with technical specifications.

5. Conduct functional testing of the installed systems.

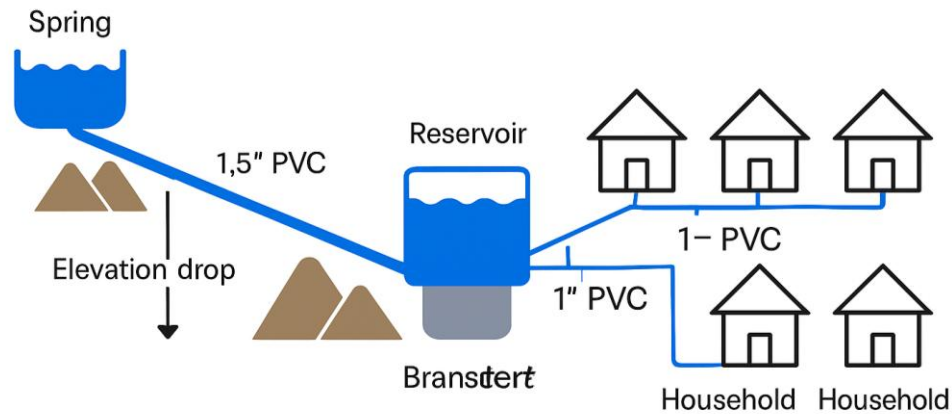


Figure 1. Schematic Diagram of the Gravity-Fed Piped Water Distribution System from Spring to Households

Methods for Training Activities

1. Determine the date and venue for the training.
2. Prepare training equipment and supporting materials.
3. Deliver the training according to the planned curriculum.
4. Evaluate the effectiveness of the training sessions.

All stages of the program involved the active participation of Drawati Village residents, village officials, and the *Masyarakat Peduli Lingkungan* group, with PT Tunas Engineering as the industry partner. Technical execution was supervised by PT Tunas Engineering to ensure that all installations met good engineering practices.



Figure 2. Community Participation in System Construction and Reservoir Installation

Following installation, system performance testing was conducted over a two-week monitoring period. Measurements included endpoint pressure, average flow rate, and leak detection to ensure optimal functionality. The system maintained a delivery rate of 1.2–1.5 liters per second during peak demand, sufficient to meet daily household water requirements.

In addition, a user satisfaction survey and qualitative interviews were conducted to assess system usability and collect feedback from the community, following the methodologies of Rahman et al. (2020) and Syahrizal & Ridwan (2021). This integrated approach combined technical feasibility with social acceptance, supporting the view that sustainable

rural water systems must be both functionally reliable and culturally appropriate (Juwana, Muttill, & Perera, 2018; Wibowo & Handayani, 2023). Documentation from each stage—including photographs, schematic diagrams, and community attendance records—was archived to facilitate replication in other nearby villages.

3. RESULTS AND DISCUSSION

3.1 Result

The main outputs achieved are as follows:

- Access to safe and reliable water was extended to 15 households that had previously been underserved. This was achieved through the construction of a piped distribution system sourced from natural springs, complemented by a filtration unit to ensure water quality and safety.
- Five units of solar-powered street lighting were strategically installed in previously unlit areas of the village, resulting in improved nighttime visibility, enhanced public safety, and greater comfort for residents.
- Thirty community members participated in structured training sessions covering digital-based asset management using Google Forms and Google Drive, in addition to acquiring hands-on technical skills in the maintenance and repair of the newly installed infrastructure.
- A community-based business entity was established, specializing in the installation and upkeep of solar-powered street lighting, creating a potential avenue for local economic activity.
- A volunteer maintenance team comprising 12 trained local residents was formally organized to ensure the continuous operation and upkeep of the solar lighting systems.

The physical works were carried out in sequential stages, including field surveys, measurements, technical design, material procurement, installation, and functional testing. Training sessions were held both at the village hall and in the field, adjusted to match the technical content.



Figure 3. Installation of solar-powered public streetlight

To provide a concise overview of the program's achievements, Table 2 summarizes the key outputs, measurable indicators, and their corresponding short-term and long-term impacts on the Drawati Village community.

Table 2. Summary of Outputs, Indicators, and Impacts of the Program

No	Key Output	Achievement Indicators	Immediate Impact	Long-Term Impact
1	Installation of a spring-fed piping system with integrated filtration unit	15 previously underserved households now have access to safe water; delivery rate of 1.2–1.5 L/s during peak demand	Increased availability of safe water for daily consumption	Reduced risk of waterborne diseases; improved quality of life
2	Installation of 5 solar-powered public streetlights at strategic locations	All dark spots identified during FGD are now illuminated	Enhanced community safety and comfort during nighttime	Supports nighttime economic activities and reduces potential crime
3	Training on asset management using Google Forms and Google Drive	30 participants acquired skills in infrastructure record-keeping and monitoring	Increased digital literacy and improved village asset governance	Ensured transparency and efficiency in infrastructure maintenance
4	Formation of a volunteer infrastructure maintenance team	12 members trained for PJU and piping system maintenance	Readiness for quick repairs in case of system failure	Sustainable infrastructure services through community-based management
5	Establishment of a local business unit for solar streetlight services	One group formed and started offering installation and maintenance services	Created job opportunities and additional income sources	Strengthened local economy through continuous technical service provision
6	Development of a digital technical manual for the village team	Development of a digital technical manual for the village team	Increased self-reliance in infrastructure maintenance	Reduced dependence on external parties for infrastructure management

3.1.1 Partner Satisfaction Evaluation

To evaluate the program's effectiveness, a partner satisfaction survey was conducted among 26 out of 30 training participants. Results are shown in Table 3.

Table 3. Partner Satisfaction Evaluation Results

No.	Aspect	Mean Score (1–5)
1	Program aligned with partner needs	4.8
2	Coordination between team and partners	4.6
3	Timeliness of activities	4.5
4	Adequacy of materials and activities	4.4
5	Practicality and applicability of solutions	4.3
6	Quality of mentoring provided	4.2
7	Tangible benefits of outputs	4.3
8	Professionalism of the team	4.5
9	Accessibility of information and communication	4.4
10	Overall satisfaction	4.6

The Partner Satisfaction Index (Index kepuasan mitra/IKM) was calculated using the following formula:

$$IKM = \frac{\text{Total Actual Score}}{\text{Maximum Score}} \times 100$$

$$\text{Total actual score} = \Sigma(\text{mean scores} \times \text{number of respondents}) = (4.8 + 4.6 + 4.5 + 4.4 + 4.3 + 4.2 + 4.3 + 4.5 + 4.4 + 4.6) \times 26 = 1147.8$$

$$\text{Maximum possible score} = 5 \times 10 \text{ aspects} \times 26 \text{ respondents} = 1300$$

$$IKM = \frac{1147.8}{1300} \times 100 = 88.29$$

This score falls under the “Very Good” category (IKM > 85).

Respondents rated the program's alignment with community needs as the highest-scoring aspect (4.8), indicating that the intervention was well-targeted and relevant. Coordination (4.6) and overall satisfaction (4.6) also received high ratings, reflecting both the operational effectiveness and the positive perception of the project team. Areas with slightly lower—though still high—scores, such as quality of mentoring (4.2) and practicality of solutions (4.3), suggest opportunities for enhancing technical delivery and clarity of instructions in future programs.



Figure 4. The student team provided assistance during the completion of the partner satisfaction survey



Figure 5. The Water Source Area (Spring) Surrounded by Natural Vegetation

3.2 Discussion

3.2.1 Technical Outcomes and Infrastructure Improvement

The installation of a piped water system with integrated filtration has significantly improved the reliability and quality of water supply for the targeted households. The system delivers sufficient daily water volume, and the filtration unit ensures compliance with quality parameters such as clarity, absence of odor, and neutral taste—factors recognized as critical for household water safety (World Health Organization [WHO], 2017). Similarly, the solar-powered

streetlights have effectively illuminated previously dark areas, aligning with findings from Xu et al. (2025) that rural lighting improvements directly enhance community safety and nighttime mobility.

3.2.2 Community Empowerment and Participation

A key strength of the program lies in its educational-participatory approach, whereby local residents were not only recipients of infrastructure but also trained as operators, maintainers, and decision-makers. This shift from dependency to autonomy reflects the principles of community-based water management highlighted by Gleick (1996), which emphasize that long-term sustainability depends on active community involvement in operation and maintenance.

The formation of dedicated volunteer teams for both solar streetlight maintenance and water infrastructure monitoring mirrors the *community-based infrastructure monitoring* framework advocated by the Asian Development Bank (ADB, 2020), which promotes localized, low-cost governance mechanisms for rural service systems.

3.2.3 Sustainability and Institutional Support

The use of simple digital tools—Google Forms and Google Drive—for asset management not only facilitates transparent record-keeping but also builds digital literacy among participants, a factor noted by OECD (2021) as increasingly important for resilient local governance. The village administration’s expressed willingness to integrate these initiatives into future development plans demonstrates institutional buy-in, a critical determinant for long-term viability (UNESCO, 2019).

Moreover, distributing concise, visually oriented technical manuals to the volunteer teams enhanced their confidence and capability. This aligns with findings by Citra et al. (2024) that context-specific, easy-to-understand educational materials are essential for effective grassroots technical training.

3.2.4 Social Impact

Socially, the program fostered a sense of collective responsibility, as evidenced by residents independently scheduling routine checks for household water connections. This behavioral change indicates an internalized sense of ownership—a known success indicator in rural infrastructure programs (Narayan, 2002). The emergence of a local business group for solar streetlight services also suggests that the intervention has potential to stimulate microeconomic activities linked to infrastructure maintenance.

4. CONCLUSION

This community service program in Drawati Village successfully addressed two critical local challenges: limited access to clean water and inadequate public street lighting. Through the installation of a spring-fed piping system with an integrated filtration unit, 15 previously underserved households gained reliable access to safe drinking water. The installation of five solar-powered public streetlights improved nighttime safety, comfort, and mobility in strategic areas of the village.

Beyond physical infrastructure, the program emphasized sustainability by building local capacity. Thirty residents were trained in asset management, basic electricity, and the use of digital tools for monitoring infrastructure. A volunteer maintenance team and a local business unit for solar streetlight services were established, ensuring technical readiness and fostering microeconomic opportunities.

The Partner Satisfaction Index score of 88.29 (“Very Good”) reflects the program’s strong alignment with community needs, effective coordination, and tangible benefits. The integrated approach—combining technical solutions, community empowerment, and institutional engagement—demonstrates a replicable model for rural infrastructure development. Future initiatives should focus on expanding coverage, enhancing technical training quality, and strengthening digital-based monitoring systems to further ensure long-term sustainability.

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