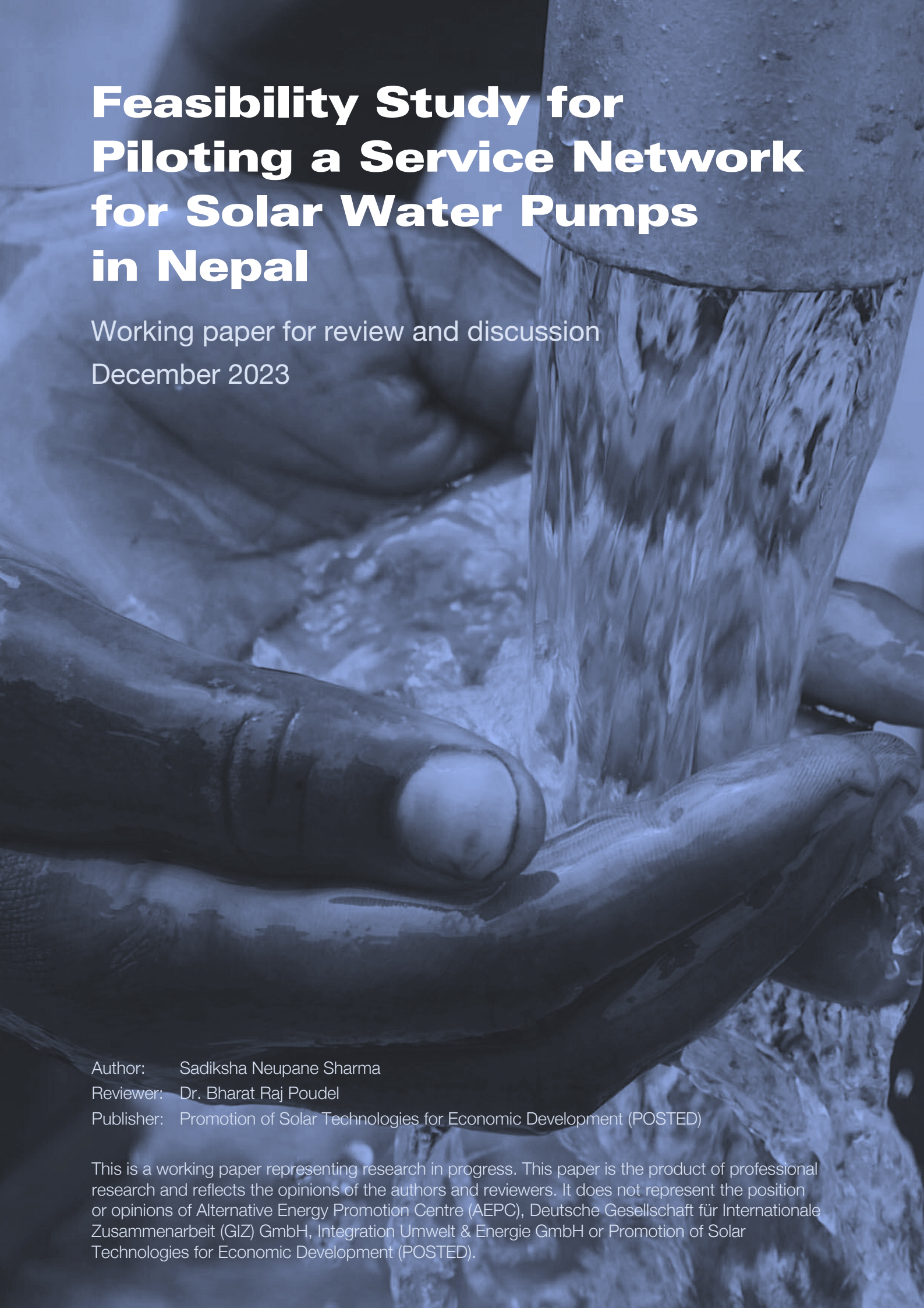


A blue-toned photograph of a hand holding a pipe. Water is flowing out of the pipe, creating a dynamic splash. The hand is positioned at the bottom left, with the thumb and fingers visible. The pipe is vertical, and the water flows downwards. The background is a textured, rocky surface.

Feasibility Study for Piloting a Service Network for Solar Water Pumps in Nepal

Working paper for review and discussion

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Author: Sadiksha Neupane Sharma

Reviewer: Dr. Bharat Raj Poudel

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Acronyms

AC	Alternating Current
AEPC	Alternative Energy Promotion Centre
B.S.	Bikram Sambat
DC	Direct Current
HP	Horse Power
km	Kilometre
MCBs	Miniature Circuit Breakers
NPR	Nepalese Rupees
POSTED	Promotion of Solar Technology for Economic Development
PV	Photovoltaics
SWP	Solar water pumps
Wp	Watt-peak

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1. Executive Summary

This survey report, "Feasibility Study for Implementing a Service Network for Solar Water Pumping (SWP) Systems in Nepal," is an initiative taken by Promotion of Solar Technology for Economic Development (POSTED), a GIZ development program operating under the Alternative Energy Promotion Center (AEPC). Its core objective is to enhance access to high-quality after-sales service for farmers using SWPs in Nepal for irrigation purposes. The study encompassed two pivotal surveys:

SWP Users Survey:

- Comprehensive assessment of SWP users' perceptions regarding the technology.
- Identification of recurring faults and issues faced by SWP users.
- Evaluation of SWP users' willingness and capacity to contribute and actively participate in local service networks.

Local Enterprises Survey:

- Identification of local enterprises willing to engage in service networks.
- Assessment of these enterprises' potential to provide repair and maintenance services to SWP users.

The survey was systematically conducted, involving desk research, questionnaires, field visits, and comprehensive data collection and analysis. It specifically focused on 2,530 SWPs installed by AEPC in Nepal, targeting specific locations such as Chitwan, Morang, and Jhapa districts. The study covered 43 individually owned and managed SWP users and 20 local enterprises within the identified clusters.

In terms of SWP users, the survey reveals a notable shift towards SWP adoption over diesel generators for irrigation, with 80% of systems installed 2-3 years ago still operational. Controller-related issues affect approximately 20% of systems, leading to cost concerns and occasional reliance on AC pumps. Many users have larger land holdings than their SWP systems can cover, indicating a relatively affluent user base. Hybrid operation and grid integration are seen as essential for effective irrigation.

Local support plays a crucial role, with users often seeking assistance from local technicians for minor issues. Streamlined repair services and improved communication with installer companies are essential for addressing technical challenges. Users express willingness to participate in survey networks, favouring a practical approach that combines local technicians for minor repairs with enterprise support for major issues.

The enterprise survey emphasizes the need for expertise in electrical, electronics, and plumbing domains for troubleshooting SWP systems, with only 1 out of 20 enterprises possessing all essential skills. Challenges like initial costs, skill gaps, and spare parts availability underscore the importance of collaboration, technical training, and dependable components.

To address these challenges, a two-layer solution is proposed: local technician training for minor repairs and a specialized service network comprising enterprises with expertise in specific domains. Users will initially contact local technicians for issue diagnosis and be referred to specialized enterprises if necessary, ensuring efficient and targeted support for solar water pump systems.

2. Introduction

2.1. Background

Nepal is an agrarian economy country and the majority of its citizens relied on diesel generators for agricultural activity in the past. With the massive adoption of renewable technologies globally, Nepal also started its journey with the help of its nodal agency Alternative Energy Promotion Centre (AEPC). To promote the adoption of renewable energy and reduce dependency on diesel water pumps, the AEPC introduced subsidies for SWP systems since 2016 with the aim to support the farmers to replace diesel water pumps. The data received from AEPC shows that until 2022, AEPC had solely supported the installation of 2,530 numbers of SWPs.

While the subsidy mechanism has facilitated the installation of numerous SWP systems, a significant challenge has surfaced regarding its sustainability due to the lack of effective after-sales service. Farmers relying on SWPs face a myriad of issues, ranging from lack of skill of this newly evolved technology and its components together with the absence of service providers leading to the limited access to timely operational and maintenance support, further exacerbated by the scarcity of skilled technicians at the local level.

The efficient after-sales service for SWPs is a critical aspect of ensuring their smooth operation and long-term sustainability. In response to these pressing challenges, POSTED initiated a groundbreaking feasibility study, with the aim of exploring the potential of establishing a robust service network dedicated to SWP systems. The envisioned service network aims to offer timely and top-notch after-sales service.

2.2. Objectives

The primary objective of this comprehensive feasibility study is to enhance and ensure easy access to quality after-sales service for farmers using SWPs in Nepal. To achieve this, the study will meticulously collect essential information about SWP systems through a well-structured survey. The key objectives of the study include:

- **Common Faults and Failure Causes:** Conduct an in-depth analysis to identify the most common issues faced by farmers using SWPs. This includes pump malfunctions, technical faults, and operational failures. Understanding these challenges will inform the development of targeted solutions and preventive measures to enhance the reliability and efficiency of SWP systems.
- **Assess the Frequency of Issues:** Quantify the frequency of issues encountered by SWP users to gain valuable insights into the scope and severity of problems. This data will aid in formulating strategies for timely interventions and prompt resolutions, minimizing downtime, and maximizing SWP performance.
- **Understand Technical Aspects of Pump Technologies:** Delve into the intricate technical aspects of SWP systems to grasp the underlying complexities and operational nuances. This understanding will guide the development of specialized training programs for service providers, ensuring their competence in addressing SWP-related issues effectively.
- **Identify Potential Enterprises for After-Sales Services:** Conduct a meticulous evaluation to identify and locate enterprises with the potential to offer efficient repair and maintenance services to SWP users. These identified enterprises will be

empowered with the necessary resources and knowledge, transforming them into reliable and economical service providers for the farming community.

By accomplishing these refined objectives, the feasibility study aims to pave the way for a sustainable and efficient service network that caters to the specific needs of SWP users. Ultimately, this initiative will ensure the prolonged functionality and seamless operation of SWP systems and align with Nepal's commitment to renewable energy solutions and proactive measures against climate change challenges. The findings of this study will serve as a vital blueprint for the successful implementation of the envisioned service network, benefiting farmers and all stakeholders.

2.3. Overview of AEPC-supported SWP systems in Nepal

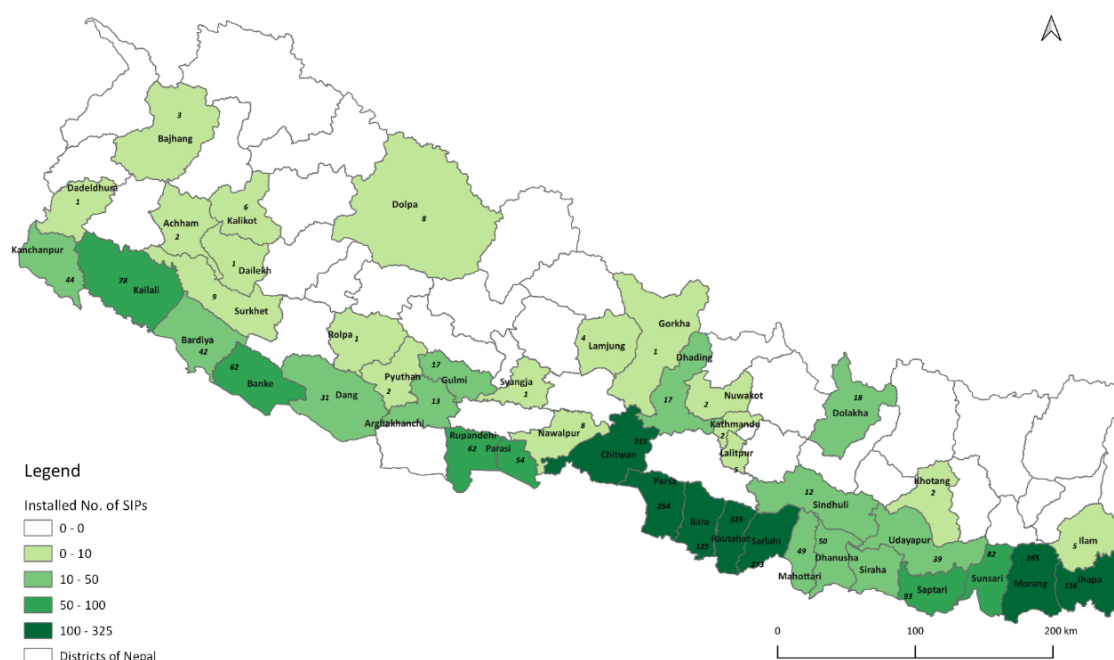


Figure 1: Distribution of SWPs for irrigation at the District Level

The AEPC initiated its support for SWPs dedicated to irrigation purposes in 2016. This support was established under the framework of the 2063 B.S. subsidy mechanism, which stipulates that AEPC provides 60% of the funding while farmers contribute the remaining 40%. Throughout the fiscal years until 2079, a significant portion of AEPC's supported SWP systems were designed for individual landowners, adhering to the subsidy guidelines. This report focuses on SWP systems that were installed before the year 2079 B.S. Based on the information furnished by AEPC representatives, a total of 2,350 SWP systems were installed from fiscal year 2075 B.S. to 2079 B.S. The report will delve into the details of these SWP systems, shedding light on their implementation areas.

2.4. Identification of Clusters for Feasibility Demonstration

The clustering approach involved the following steps. This methodology enabled us to pinpoint regions with the highest concentration of SWP installations across all seven provinces during the four financial years.

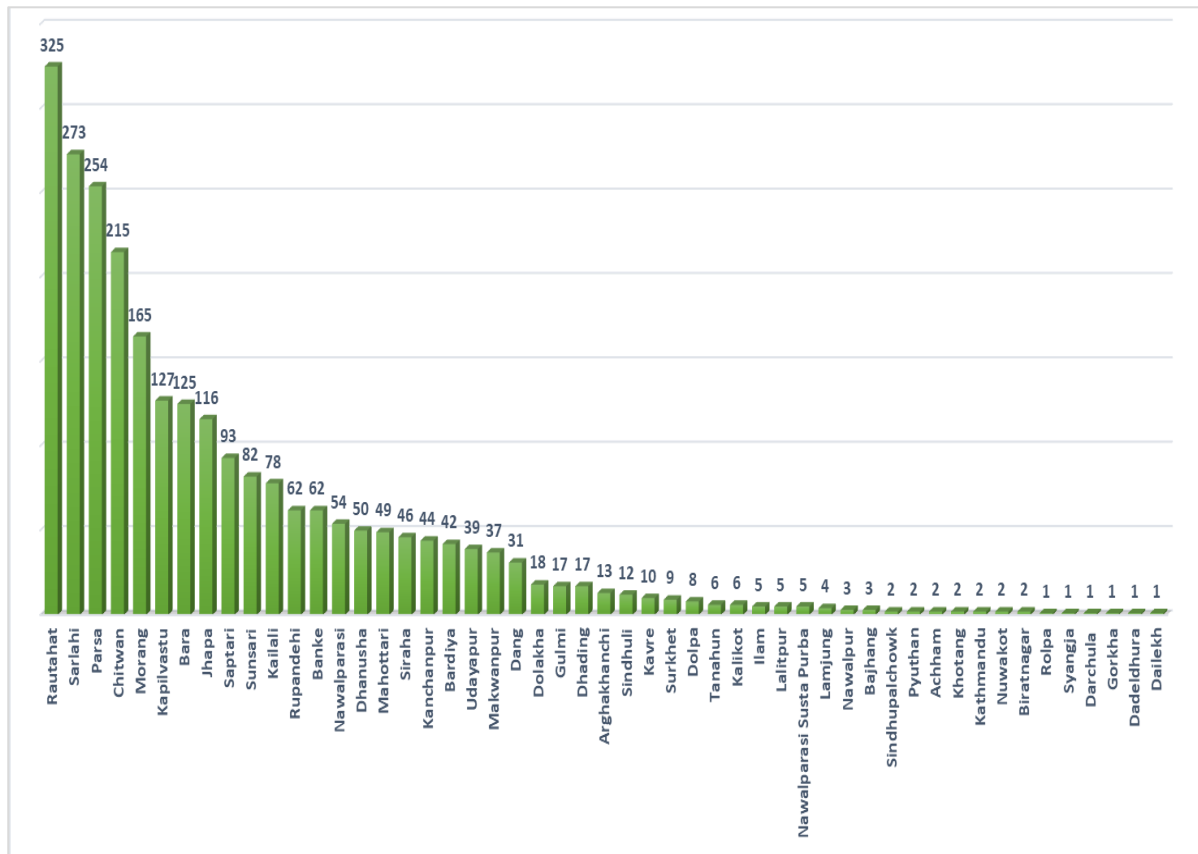


Figure 2: Districts with Dense SWP Installations

- Firstly, districts with over 100 SWP installations were singled out from Figure 2, and their distribution was outlined at both Municipality and Rural Municipality levels.
- Secondly, from the top 8 districts, the most densely populated 3 municipalities/rural municipalities were pinpointed.
- Afterwards, for dense municipalities, a nearby urban centre was identified and plotted on Google Earth (Figure 3). The detail list of the dense municipalities is tabulated in Annexe I.
- The Damak (city) and Narayanghad (city) were chosen as the nearby market centres for surveying the enterprises.

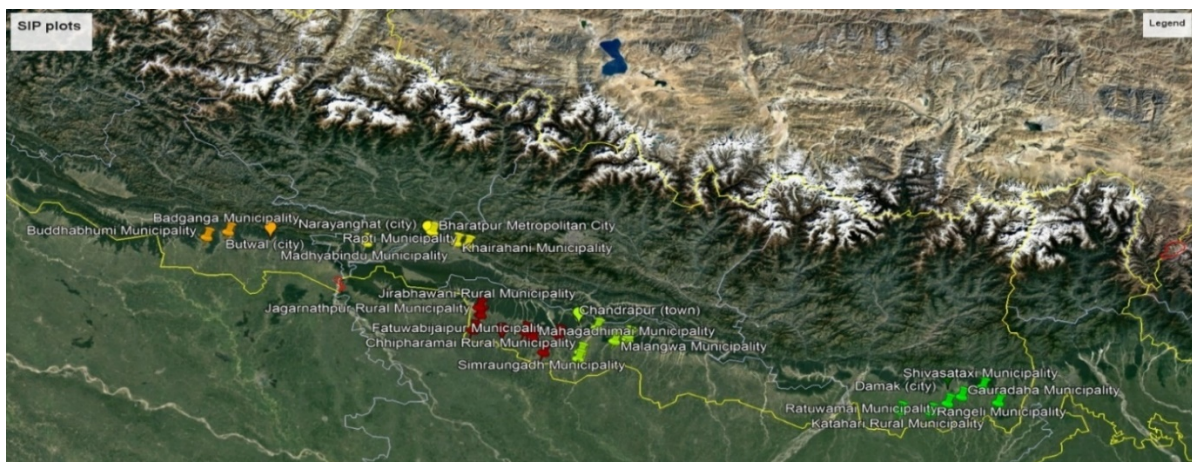


Figure 3: Dense Municipalities and Nearest Market Centre

3. Operational, Management, and Maintenance Issues

Operational, management, and maintenance issues related to solar water pumps for irrigation can significantly impact their efficiency and effectiveness. Here are some common challenges and considerations in these areas that need to be considered for future SWPs. These considerations have been compiled based on consultations with installer company technicians, suppliers, and their collective experiences.

3.1. Operational Issues

- **Solar Panel Efficiency:** Solar water pumps depend on sunlight to generate power. Issues such as shading from trees or structures and reduced panel efficiency due to dirt or dust can affect their performance.
- **Pump Blockages:** Debris, sediments, or contaminants in the water source can lead to pump blockages, reducing water flow and efficiency.
- **Pump Motor Malfunctions:** Mechanical or electrical problems in the pump's motor can disrupt its operation, leading to reduced pumping capacity.
- **Water Source Problems:** Irregular water sources, changes in water levels, or variations in water quality can pose operational challenges for solar water pumps.

3.2. Management Issues

- **System Sizing and Design:** Inaccurate estimations of water demand or improper system design can result in either undersized or oversized systems, impacting overall efficiency.
- **Financial Viability:** High upfront costs for solar water pump installations and limited access to financing options can deter potential users as incentives are not accessible to all.
- **Technical Knowledge:** Users may lack the necessary technical knowledge for system operation, troubleshooting, and maintenance, leading to inefficiencies and breakdowns.
- **Policy and Regulation:** The absence of supportive policies, incentives, or regulations for solar water pumps can hinder their widespread adoption and proper management.

3.3. Maintenance Issues

- **Regular System Maintenance:** Routine cleaning and maintenance of solar panels, pumps, and other components are essential for optimal performance. Neglecting these tasks can result in reduced efficiency and breakdowns.
- **Spare Parts Availability:** Access to genuine spare parts for repairs and replacements can be challenging in some regions, impacting the timely restoration of malfunctioning systems.
- **Technical Support:** Prompt technical support for troubleshooting and repairs is crucial to minimize system downtime and ensure continuous operation.

3.4. After-Sales Service Provisions

As per the technical documents governing solar water pumps primarily intended for irrigation, AEPC has established after-sales service provisions that extend for the initial two years following installation. These provisions are critical in ensuring the continued efficient operation of SWP systems and addressing any technical issues that may arise during this crucial period. However, it's important to note that the sustainability of SWP systems may benefit from extending the after-sales service period or exploring additional maintenance strategies beyond the initial two years. Also, most of the installer companies qualified for installations are located in Kathmandu while solar water pumps are installed mostly in the Terai region.

4. Overall Findings of the SWP Users Survey

The conclusions and outcomes outlined herein stem from the survey undertaken in three specific districts (see Annexe III for the questionnaire). It's important to note that these findings offer insights specific to these regions and might not universally represent all districts. The primary objective of this feasibility study is to assess the requirement for a service network at the grassroots level and the potential for its establishment through local enterprises. See Annexe V for a photo of interaction with the SWP users.

4.1. District Wise Sample

The survey comprehensively covered 43 SWP systems, primarily utilized for irrigation as indicated in Figure 4. The main objective was to gather insights from the end-user perspective. This survey was conducted across 3 districts as illustrated, which were chosen based on the proportion of SWPs installed from Fiscal Year 2075 B.S. onwards. This approach ensured a strategic selection of districts that are actively engaged in the use of SWP systems, allowing for a meaningful representation of current SWP usage and challenges.

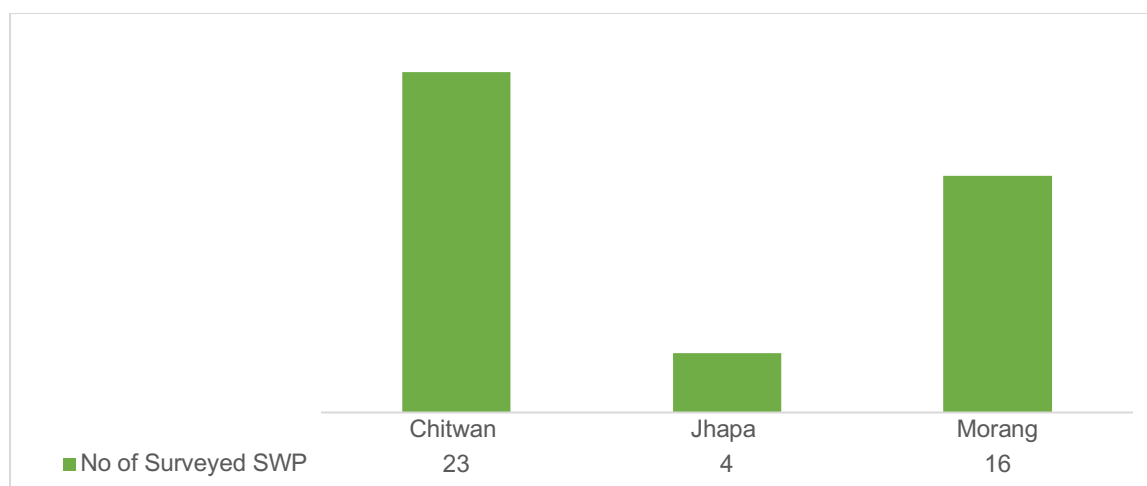


Figure 4: Number of Surveyed SWPs

4.2. Distribution of Surveyed SWP Systems Across Installation Years

This segment provides a comprehensive analysis of the distribution of SWP installations based on their respective installation years within the surveyed dataset of 43 SWP systems (Figure 5). It can be inferred that the installation pattern for the past 4-5 years has predominantly supported individual households, although this pattern may have shifted from 2079 B.S. onward, reflecting more community-owned projects. This distribution underscores the evolving pattern of SWP adoption within the studied region, highlighting the data available until 2078 B.S. and the one SWP surveyed in 2079 B.S.

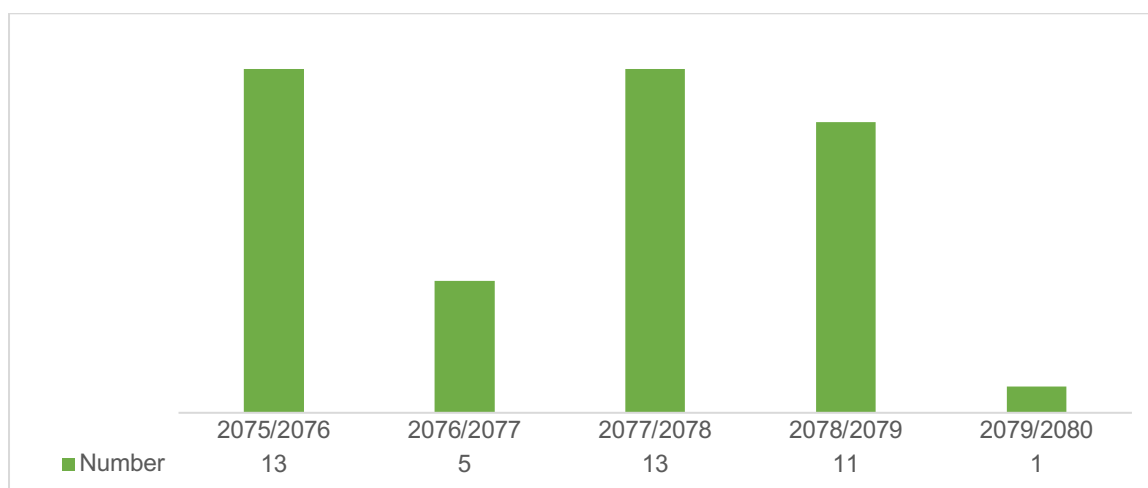


Figure 5: Installation Years (in B.S.) for Surveyed SWPs

4.3. Assessment of Socio-Economic Characteristics of SWP users

4.3.1. Gender Distribution and Household Head of SWP Owners

The analysis of the gender distribution of SWP ownership among the surveyed samples reveals significant insights. Out of the total of 43 SWP owners, 12 are female, representing 28% of the ownership. The majority, comprising 31 owners, are male accounting for 72% (Figure 6).

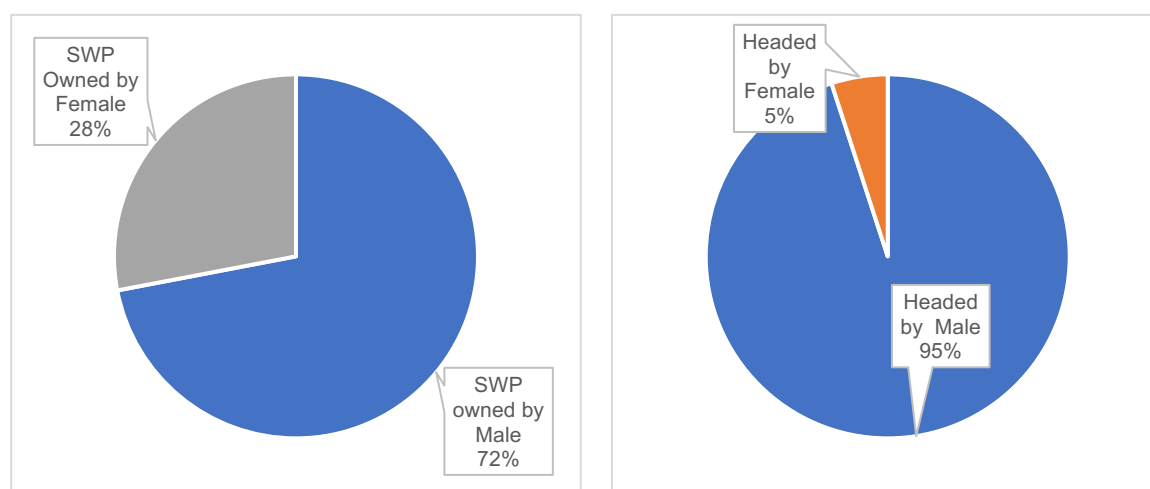


Figure 6: Gender Distribution and HH

Further adding to the gender-related findings, it is evident that the surveyed households are predominantly led by male heads. Among the 43 households, a substantial 41 (95%) are headed by males, while only 2 (5%) are led by females (Figure 6).

4.3.2. Access to Basic Facilities

Every household in the surveyed community has access to essential amenities, including toilets, clean drinking water, communication services via radio and television, and the availability of the national power grid. The presence of these basis facilities underscores that all surveyed users have access to essential facilities. This also raises the prospect of their

potential contribution to the maintenance and repair of SWP systems in the future, as the need arises.

4.3.3. Education level of SWP Users

The education levels of SWP owners vary widely, with around 35% being illiterate (Figure 7). This highlights the need for user-friendly training and support materials. To ensure accessibility and benefits for all users, tailored training programs are essential, considering the diverse educational backgrounds. This approach empowers SWP users, regardless of education, for effective system operation and maintenance, fostering agricultural sustainability and inclusivity.

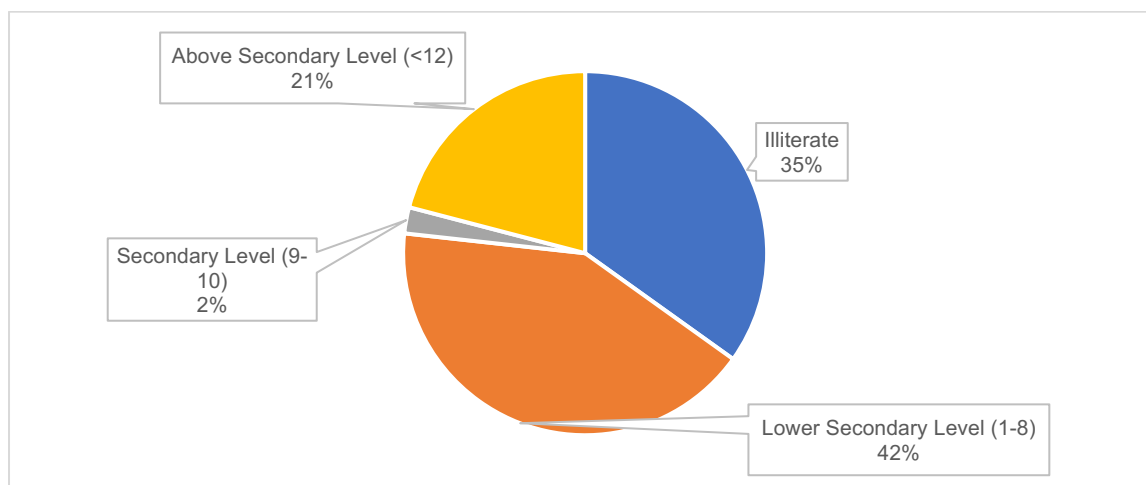


Figure 7: Education Level

4.3.4. Occupation and Income Diversity Among SWP Users

All 43 respondents primarily depend on agriculture as their main occupation, emphasizing its central role in their livelihoods. Additionally, 22 (51%) of them have additional income sources due to challenges in sustaining themselves solely through agriculture. This highlights the prevalence of agriculture among the surveyed users. Among those with supplementary income sources, the sources were diverse. Remittances were a significant additional income source, while others were involved in government services, personal businesses, or private firms (Figure 8). These findings highlight the diverse nature of supplementary income among the surveyed owners, with agriculture remaining at the core of their livelihoods.

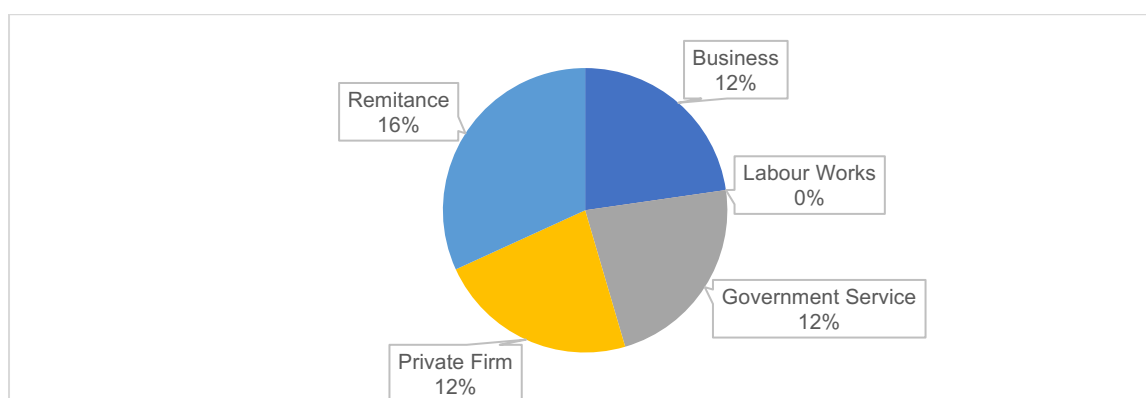


Figure 8: Type of Additional Source of Income

4.4. Sources of Financial Support for Installation

Out of the 43 surveyed SWP systems, a substantial 95% (41 systems) were funded by AEPC, while the remaining 5% (2 systems) received financial assistance from Gyan Kendra (Agriculture Knowledge Centre) in the Chitwan district (Figure 9).

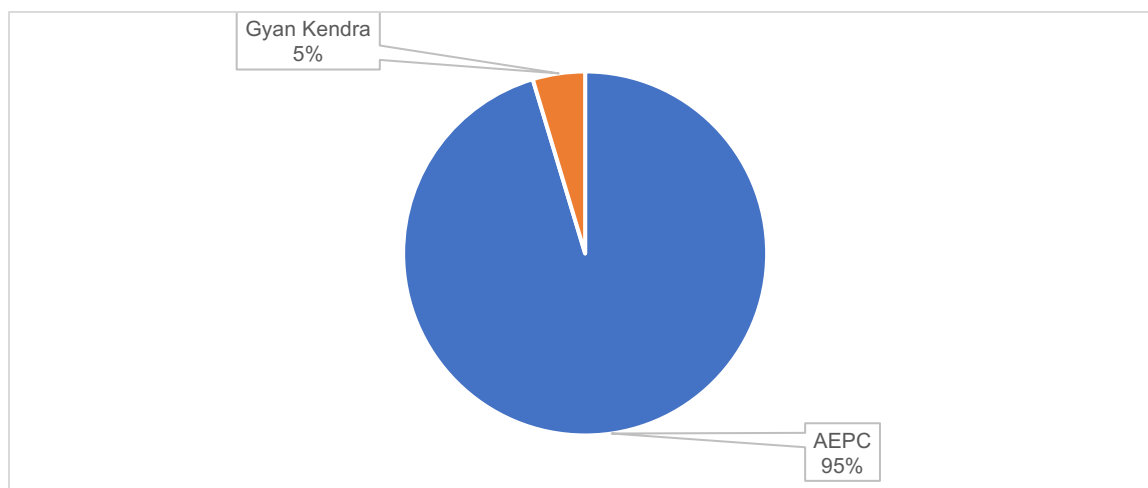


Figure 9: Financial Source for SWP Installation

AEPC deviated from the standard subsidy policy by fully covering the total system cost for all surveyed SWP systems, normally requiring a 60-40 split with users. Most users reported minimal financial contributions, with AEPC bearing the entire cost. Some respondents, whose systems were installed 4-5 years ago, contributed NPR 2,000 but haven't received reimbursement, indicating a gap between policy and user experiences.

4.5. Ownership and Management

The ownership of surveyed SWP systems is noteworthy. A significant 86% of the systems are owned by the landowners themselves, reflecting their direct involvement (Figure 10). In contrast, 14% are owned by immediate family members, with no ownership by installer companies. This distribution underscores the strong individual and family engagement in owning and managing SWP systems.

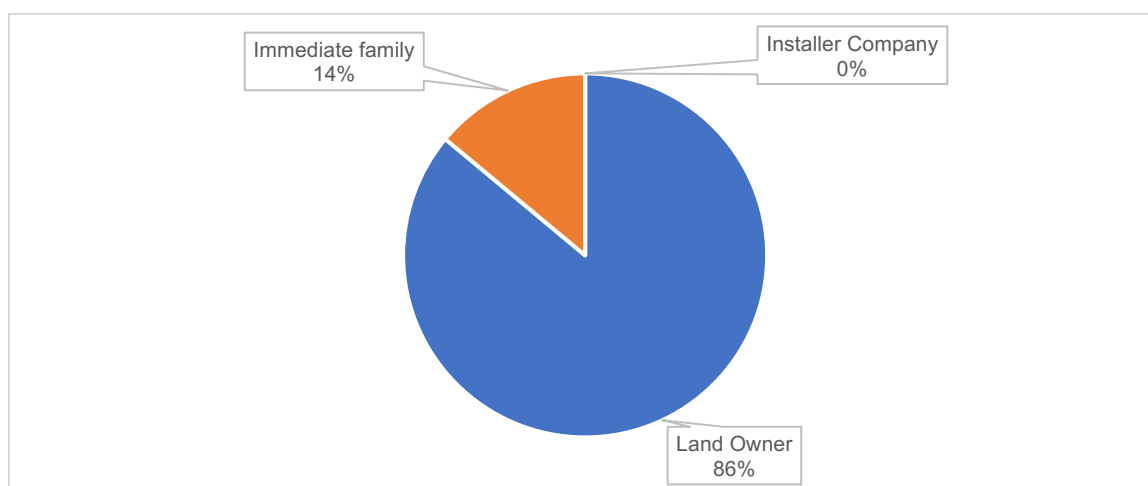


Figure 10: Ownership of SWPs

4.6. Basic Day-to-Day operation of SWP

Operational and maintenance roles are actively managed by landowners and their families. Among surveyed systems, 35% are directly managed by landowners, while 63% are handled by immediate family members (Figure 11). A minor 2% are overseen by others, possibly tenants. No installer companies supervise systems post-warranty, highlighting the reliance on family members for basic operation.

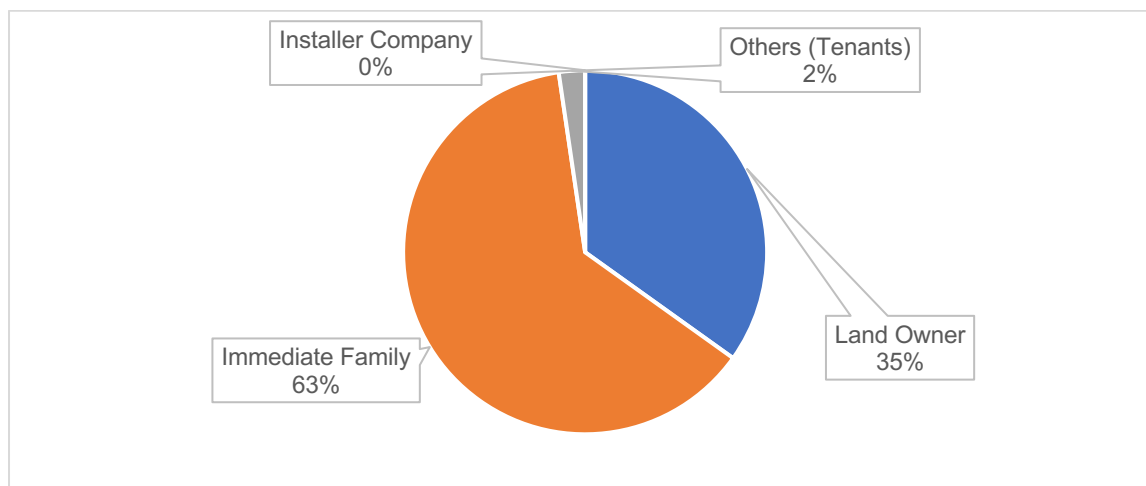


Figure 11: Operation and Maintenance Roles

4.7. Key Features of the SWP Systems

4.7.1. Capacity of the PV array

The surveyed 43 SWP systems displayed varying PV array sizes, ranging from a minimum of 1,200 Wp to a maximum of 3,900 Wp. These diverse sizes highlight the adaptability of SWP systems to meet different energy requirements, allowing customization based on user-specific needs. The size of the PV arrays correlates with the pump's horsepower (HP) and water requirements. Larger pumps with higher water needs necessitate larger PV arrays to effectively meet their energy demands. It's worth noting that various pump brands and controllers were used for similar water requirements in the surveyed area, resulting in different PV array sizes aligned with controller specifications, all meeting or exceeding the recommended standardized PV array size.

Table 1: Range of PV Array for Varying Pump Sizes

Capacity Of PV Array For 1 HP Pumps	Wp
Minimum	1,200
Maximum	1,530
Average	1,360
Capacity of PV array for 2 HP Pumps	Wp
Minimum	1,625
Maximum	2,835
Average	1,920
Capacity of PV array for 3 HP Pumps	Wp
Minimum	2,400
Maximum	3,900
Average	3,150

4.7.2. Discharge Rate, Head and Well Parameters

In this section, we delve into the essential aspects of discharge rates, head references, and well parameters observed among the 43 surveyed SWP systems. The data extracted from the main file provides a consistent trend across these systems.

Discharge (litres/day): The discharge values exhibit a regular range, ranging from 100,000 to 300,000 litres per day, showcasing a commonality in the water delivery capacity of these systems.

Head (m): A standardized minimum head of 10 meters has been uniformly implemented across all installations, underlining the consistent design approach undertaken in these setups.

Diameter of Shallow Tube well/Boring (inch): Primarily, a 4-inch diameter has been observed, although there are instances where a 2-inch diameter is noted. This parameter contributes to the efficiency of water extraction.

Depth of Shallow Tube well/Boring (feet): The depths of the shallow tube wells or borings, display intriguing variations. The recorded depths span from 30 to 135 feet, reflecting the diversity of water source accessibility. An average depth of approximately 50.8 feet provides an overview of the depth landscape.

This variance in depths highlights the diverse hydrogeological characteristics of the region, where some areas feature shallower water sources while others necessitate drilling to greater depths to tap into water reservoirs. The depth of the water source is a critical factor in determining the efficiency and effectiveness of SWP systems, as it directly affects the pump's ability to lift water to the surface for various agricultural and domestic uses.

4.7.1. Remote Monitoring and Flowmeter Systems

None of the 43 surveyed sites featured remote monitoring systems or flowmeters. The available data indicates that 1 HP systems are designed to yield 100,000 litres per day, while 2 HP systems are designed for a daily output of 200,000 litres, and so forth. This absence of remote monitoring and flowmeter systems highlights a potential area for enhancing the operational efficiency and data collection capabilities of the SWP systems.

4.7.2. Type of SWP based on Water and Power Sources

The choice between submersible and surface pumps depends on the water source's depth, while the choice between AC and DC pumps depends on the type of electrical power the solar panels provide and the specific system setup.

Based on the Water Source

The distribution of SWP systems in the surveyed sample reveals two main types based on their design ([Figure 12](#)).

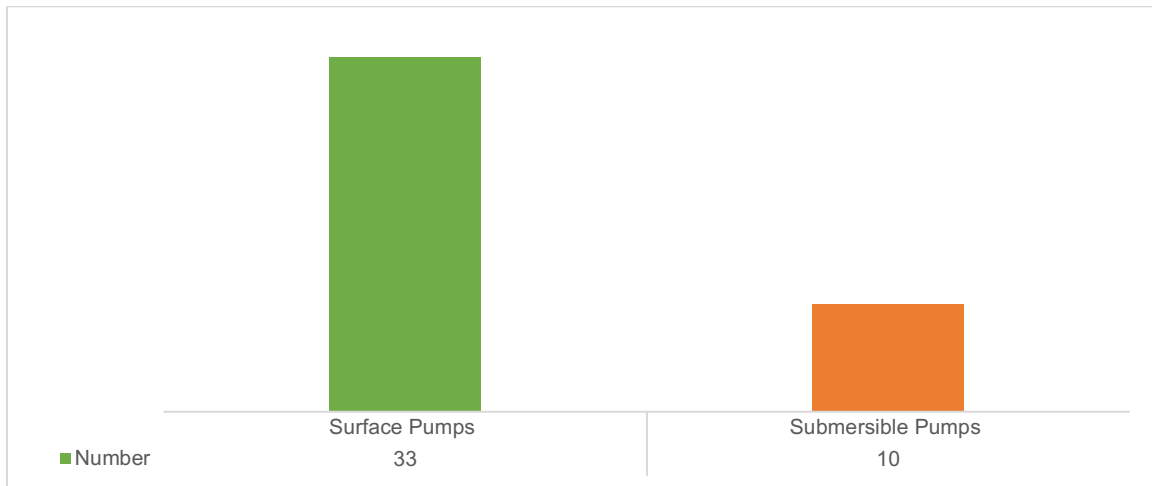


Figure 12: Submersible and Surface Pump Distribution

- **Submersible Pumps:** These pumps are designed to be submerged in the water source, facilitating the direct pumping of water from underwater. Typically, submersible pumps are employed for pumping operations requiring higher heads and tend to be more expensive than surface pumps. It's significant that 10 submersible pumps installed in the surveyed area were primarily adopted during the initial SWP technology phase in FY 2075 B.S., featuring built-in controllers. However, post-2075 B.S., the use of submersible pumps declined for irrigation purposes in the region due to revised technical standards and cost considerations.
- **Surface Pumps:** These systems are designed to be placed above the water source on the land and use a suction mechanism to draw water. Surface pumps are the prevalent choice in the surveyed area, particularly suitable for irrigation due to their compatibility with lower head and water requirements. In addition to this, they are also cost-effective compared to submersible pumps. Post 2075 B.S., all the remaining 33 SWP systems employed within the surveyed region employed surface pumps.

Based on Power Source: DC and AC Pumps

The categorization of SWP systems based on their power source and design reveals a distribution as shown in [Figure 13](#).

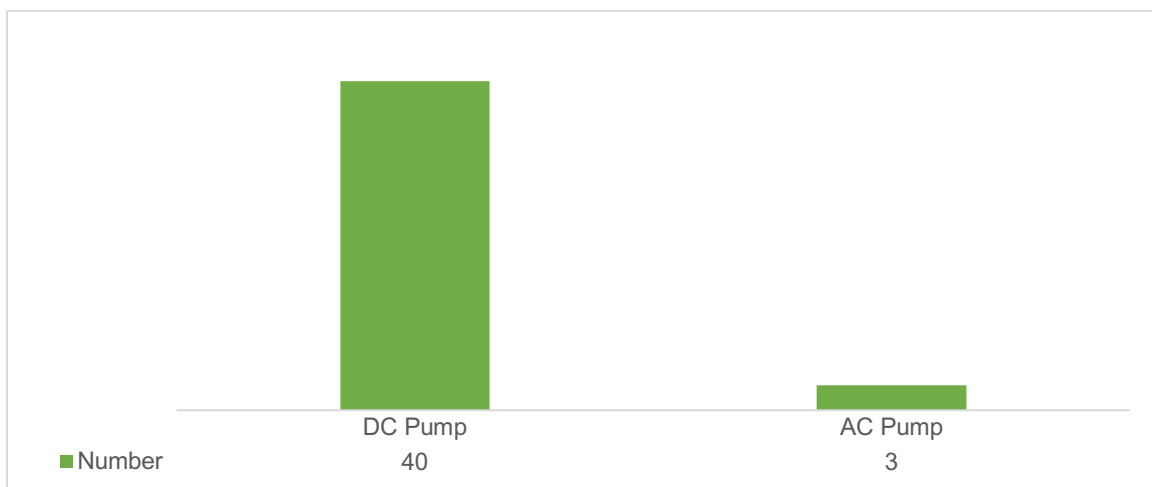


Figure 13: DC & AC Pump Distribution

- **DC Pumps:** These pumps operate directly on the electricity produced by solar panels. Among the surveyed SWP systems, 93% (40 systems) are powered by DC (Direct Current). The widespread use of DC-powered pumps in the surveyed region is due to AEPC's mandate for their exclusive use in solar water pumping systems, promoting eco-friendly and sustainable water pumping solutions.
- **AC Pumps:** These pumps utilize electricity from the local grid or an inverter, which converts solar-generated DC power into AC power. A smaller proportion, 7% (3 systems), is AC (Alternating Current) pumps which were installed up to FY 2076 B.S., only DC pumps were found to be used as one of the mandates of the AEPC subsidy guideline.

4.7.3. Controller Types and their Distribution

The survey examined the types of controllers used in SWP systems, revealing diverse technological preferences. Among the surveyed systems, 32 SWP systems (74%) utilized DC controllers, which regulate the power flow from solar panels to the pump (Figure 14).

In contrast, hybrid controllers, which combine features of both AC and DC power sources, were employed in 11 numbers of the systems.

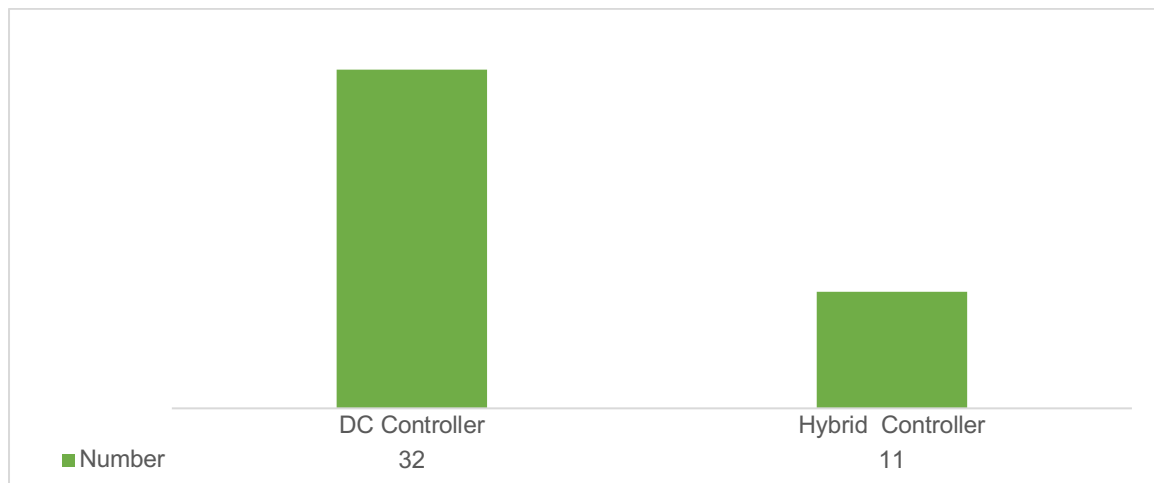


Figure 14: Controller Type and Distribution

Illustrative Case: Demonstrating Hybrid Controller Benefits

User experiences, exemplified by respondent Damber Kumari Khanal, highlight the benefits of hybrid controllers in SWP systems. These controllers enable seamless switching between solar and alternate power sources during low sunlight periods, ensuring uninterrupted pump operation. This flexibility empowers users to optimize SWP usage, particularly when solar power is limited, ensuring a dependable water supply even in adverse weather conditions.

The preference for hybrid controllers over traditional DC controllers, which can operate from both solar panels and the national grid, reflects the needs of SWP users. SWP systems, due to their intermittent nature, may not entirely meet all irrigation requirements, prompting users to seek more reliable solutions like hybrid systems.

While the current AEPC subsidy guideline gives preference to users located at least 300 meters away from the national grid, it's crucial to adopt a more comprehensive perspective. The Nepal Government actively encourages farmers across the nation to utilize subsidized agricultural AC energy meters. Additionally, it's foreseeable that many currently unelectrified areas will gradually gain access to electricity in the near future. In light of these developments, it is wise to place a greater emphasis on integrating SWP systems with the grid, while also considering policy revisions to embrace hybrid systems capable of operating from both DC and AC sources. This strategic approach aligns with the objective of optimizing SWP system utilization and ensuring their continued effectiveness as more areas become grid-connected. Grid integration not only provides the flexibility to import power from the national grid during periods of low solar energy generation but also enables the export of surplus energy during peak generation times, resulting in improved overall system efficiency and enhanced grid stability.

4.7.4. Brands of Pumps and Controllers in SWP Systems: Installer's Preferences

The study delves into the choices made by installer companies when it comes to selecting brands of pumps and controllers for SWP systems. The analysis of the distribution across surveyed systems sheds light on an interesting pattern (Figure 15).

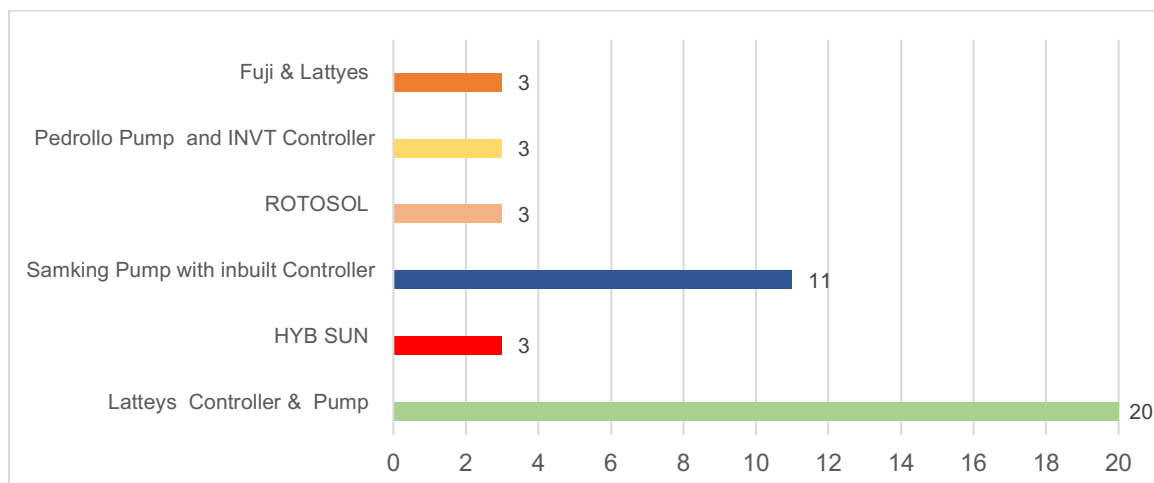


Figure 15: Pump and Controllers Brands

This distribution highlights a significant inclination among installer companies towards the Latteys brand, which dominates with nearly half of the surveyed systems employing it. The diverse choices of other brands underscore the adaptability to specific needs within the SWP installation domain.

Of particular interest, INVT and Fuji and a few of the Latteys controllers stand out due to their capability to integrate AC sources. This feature has garnered appreciation from users as it enables these systems to function during rainy or nighttime hours when solar power may be intermittent. This adaptability through AC integration enhances the usability and reliability of the pumps, addressing common concerns regarding solar-powered systems. Amidst this diverse landscape of preferences, the prominence of Latteys brand underscores its widespread acceptance by installer companies in the SWP installation domain.

4.7.5. Types of Mounting Structures in SWP Systems

The survey highlights the diverse types of mounting structures employed in SWP systems, shedding light on the prevailing trends (Figure 16).

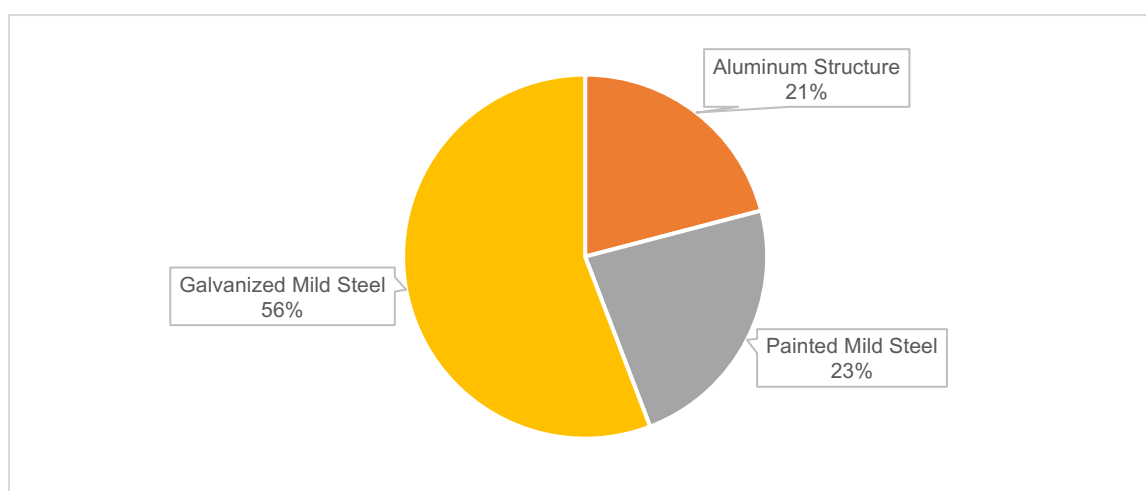


Figure 16: Type of Mounting Structures

Among these choices, galvanized mild steel emerges as the most widely embraced option, indicating its durability and suitability for supporting SWP systems effectively. Predominantly, the supporting structures of the SWP systems that were installed around 3-4 years ago exhibit signs of corrosion, necessitating additional painting to avert further deterioration. Thus, in coming installations, it is recommended that the installer companies install a mounting structure which will be strong enough to support the PV array against the strong wind

Illustrative Example: Importance of Robust Mounting Structure

An illustrative case highlights the significance of a sturdy mounting structure. Sikharam Mahato, a respondent whose SWP system was installed in the year 2078 B.S., reported that the mounting structure appeared shaky, raising concerns about its stability. This case underscores the necessity for a well-designed and resilient mounting structure to ensure the long-term stability and efficient functioning of SWP systems.

4.8. Primary Use of Water in SWP Systems: Diverse Utilization

The use of water from the surveyed SWP systems serves a range of purposes, with users given options to select their preferred water utilization. Notably, a significant proportion of these systems, especially those located near user residences, fulfil multiple roles. In addition to their primary function of irrigation, they also serve as crucial sources for domestic water supply and livestock watering, highlighting their multifunctional significance in improving livelihoods.

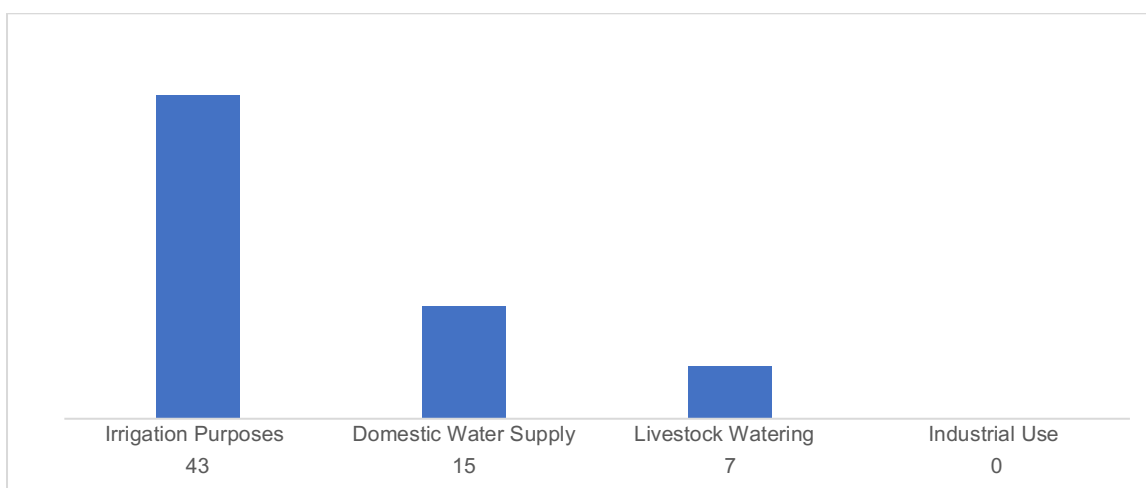


Figure 17: Water Utilization Patterns (in Numbers)

4.9. Water Storage and Distribution Strategies

The survey provides insight into the water storage and distribution mechanisms employed by the SWP systems. The results are summarized as follows:

4.9.1. Storage Mechanism

Regarding water storage and distribution methods, when users were presented with options including Direct Usage Without Storage, Stored in Tanks and Manual Distribution, Stored in Tanks with Gravity-Fed Distribution, and Stored in Tanks with Pressurized Distribution (Piped). It's noteworthy that all 43 respondents unanimously preferred the option of Direct Usage Without Storage. This unanimous preference underscores the users' inclination towards immediate water utilization without the need for storage or additional distribution mechanisms.

4.9.2. Distribution Mechanism

All 43 surveyed SWP systems, comprising 100% of the sample, use a combination of traditional canals and delivery pipes for water distribution, highlighting the preference for an efficient and reliable hybrid approach.

4.10. Cropping Patterns

In the context of cropping patterns, a substantial majority of the surveyed households follow a tri-cropping approach, primarily cultivating paddy, maize, and mustard. The cropping patterns for these crops are shown in [Table 2](#).

Table 2: Cropping Pattern

Water Requirements	High Water required Months					Minimal Water			Moderate water Required			
Cropping Patterns /Months	Asar	Shrawan	Bhadra	Asoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Bhaishak	Jestha
Rice-Mustard-Maize	Rice					Mustard			Maize			
Rice-Mustard-Fallow- Rice	Rice					Mustard			Fallow	Rice		
Rice-Others Beans -Fallow	Rice					Cheakpeas/Orange Lentins /BuckWheat/Alas					Fallow	

- **Rice/Paddy:** Rice, locally known as "Bharkhe Kheti," holds a crucial place in the agricultural cycle, primarily grown for a single season that aligns with the monsoon. This cultivation period starts from the Nepali month of Asar and continues until Kartik. All 43 survey participants are actively engaged in rice cultivation. The process typically spans five months, covering the entire cycle from seed germination to harvest.
- **Mustard:** Mustard cultivation takes place for a single season, particularly during the winter months following the rice harvest. Notably, mustard stands out as a crop that doesn't demand abundant water for its development. This practice also witnesses unanimous engagement from all 43 surveyed participants. The complete cycle of mustard cultivation spans around 75 days from Mangsir to Magh, encompassing the period from seed germination to harvesting.
- **Rice/Maize:** This cropping pattern involves cultivating either paddy or maize, primarily during the dry season, which generally spans from the month of Falgun to Jestha. This cultivation operates on a rotational basis, allowing for optimal land use. Similar to rice, all 43 surveyed participants engage in the cultivation of maize.
- **Commercial Vegetation:** A subset of the participants, precisely 6 out of 43, is engaged in cultivating commercial vegetation.
- **Others:** One respondent out of the 43 reported cultivating diverse crop types like Cheakpeas, Organge Lenils, Buckwheat and alas not explicitly classified in the aforementioned categories.

This variety of cropping patterns highlights a dynamic agricultural landscape that revolves around staple crops like paddy, maize, and mustard. Furthermore, this pattern is supplemented by an inclination toward commercial vegetation farming among a segment of the surveyed participants. The cultivation of each mentioned crop is predominantly concentrated within a single season, with rotation practices observed in specific cases.

4.11. Land Holdings vs. Land Irrigated by SWP

On average, the surveyed individuals possess approximately 26.6 Katthas of land. The land holdings vary, with the minimum reported at 10 Katthas and the maximum at 120 Katthas.

Regarding land irrigated by SWP systems, the results show an average of 11.5 Katthas. The minimum area reported to be irrigated by SWP is 3 Katthas, while the maximum reaches 24 Katthas (Table 3). These figures underscore the range of land sizes being cultivated with the assistance of SWP systems, reflecting the diversity of agricultural practices among respondents.

Table 3: Land Holdings of SWP Owner vs. Land Irrigated by SWP

	Land Holdings in Kattha	Land Irrigated by SWP in Kattha
Average	26.6	11.5
Minimum	10	3
Maximum	120	24

The data indeed suggests that the installed SWP systems may not fully meet the water requirements of its users. This observation is supported by the fact that all surveyed users have larger land holdings compared to the land area actually irrigated by the SWP system.

The underlying reason for this discrepancy appears to be the standardized design procedures employed by AEPC for calculating water requirements, which are based solely

on land area and do not account for variations in crop types or specific irrigation needs. This approach may not fully align with the diverse agricultural practices and water demands of individual users.

As a result, there may be room for optimization by considering factors beyond the land area, such as crop types, soil conditions, and local water availability, in order to ensure that SWP systems effectively fulfil the water requirements of users and support sustainable agricultural practices.

4.12. Irrigation Practices Pre- and Post-SWP Adoption

The survey assessed irrigation methods before and after the adoption of Solar Water Pump (SWP) systems. Prior to SWP implementation, respondents used various methods, including AC pumps, diesel generators, rainwater, and a combination of these, depending on their circumstances.

After adopting SWP systems, respondents' irrigation methods transformed significantly. In areas without grid access, 5% used a combination of SWPs and diesel generators. A larger group (47%) adopted a hybrid approach, combining SWPs with AC pumps. Only 2% continued using AC pumps exclusively, likely due to non-operational SWP systems. Remarkably, 47% of respondents shifted entirely to SWPs for irrigation. This shift highlights the substantial impact of SWP systems on changing traditional irrigation practices **Figure 18**.

The introduction of SWP systems has revolutionized irrigation practices, replacing older methods like AC pumps and diesel generators. Users have transitioned to more sustainable and efficient SWP systems, even integrating them with existing technologies. This shift underscores the potential of SWP systems to transform irrigation methods.

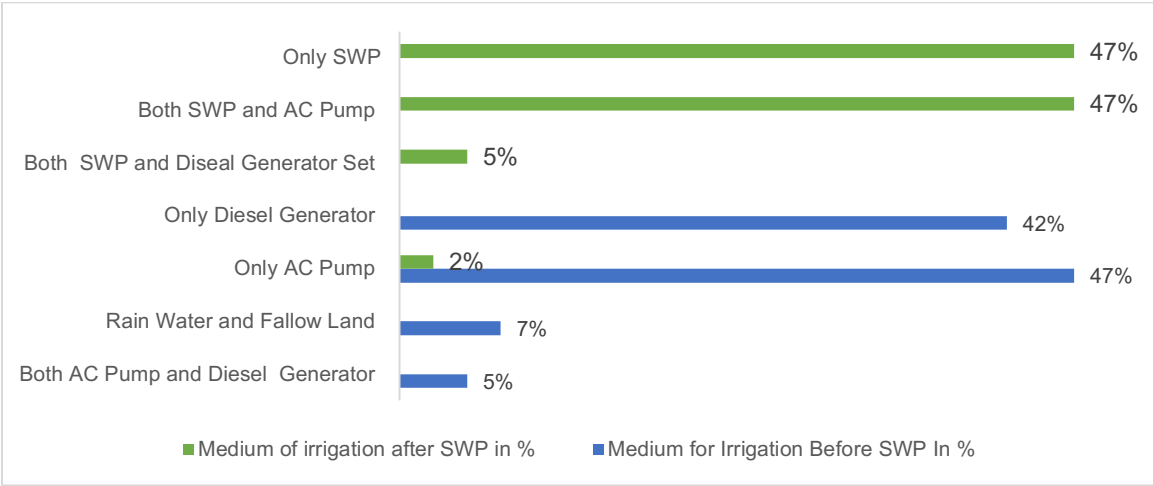


Figure 18: Comparison of Irrigation Practice Before and After SWPs

4.13. Analysis of Key Operational Issues Encountered

4.13.1. List of Key operational Issues

This section presents an overview of the operational issues identified in the surveyed SWP systems over the past years, encompassing within surveyed systems.

Among the surveyed SWP owners, 42% (18) reported not requiring any repairs or maintenance, while 58% (25) acknowledged the need for repair and maintenance services

and the list of key operational issues reported by the SWP users for those 25 issues have been provided below in the highest order of occurrences (**Figure 19**).

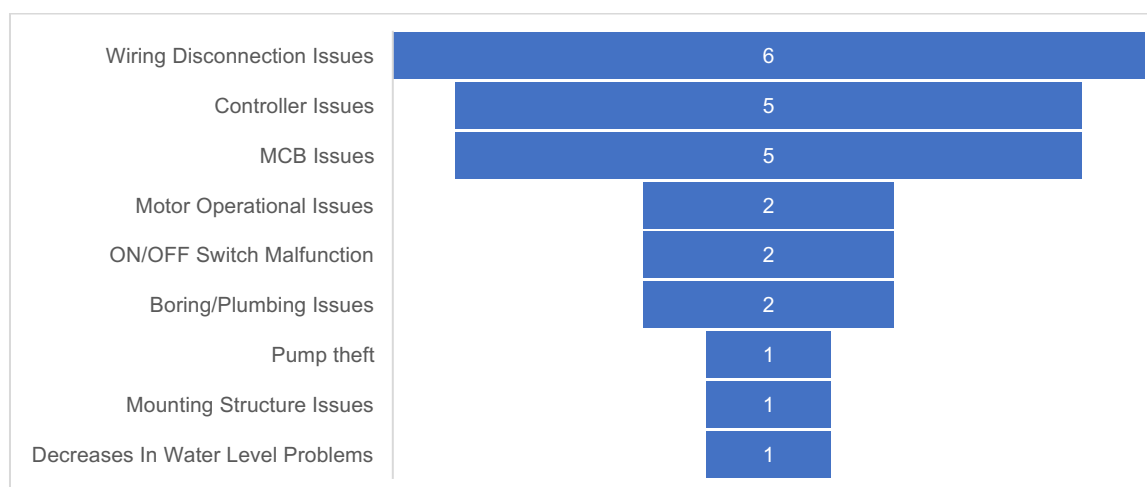


Figure 19: Key Operational Issues

4.13.2. Minor Repair and Maintenance

Out of the 25 acknowledged issues, 15 have been successfully resolved, while 10 remain unresolved which are considered non-operational systems (**Table 4**). Two instances of major repairs like motor and controller malfunction were rectified by the installer company technician, as they were under the warranty period. Meanwhile, 15 repairs were conducted at the local level with the help of local technicians and plumbers, like changing fused miniature circuit breakers (MCBs), rewiring loose connections, and adjusting pump heights in wells. **Table 4** provides an overview of the repair and maintenance scenario within the surveyed SWP systems, highlighting the distribution of issues, their resolution status, and the involvement of both installer company technicians and local users in addressing these challenges. **Local technicians played a pivotal role in swiftly resolving issues like changing fused MCBs, rewiring loose connections, and adjusting pump heights. Their knowledge of the systems and familiarity with local conditions allowed for efficient troubleshooting.**

Table 4: Minor Repair and Maintenance Table

Issues	Resolved Issues	Unresolved Issues	Troubleshoot By
Pump theft		1	
Mounting Structure Issues		1	
Wiring Disconnection Issues	6		Local User
Motor Operational Issues		2	
Controller Issues	1	4	Installer Company Technician
MCB Issues	5		Local User
ON/OFF Switch Malfunction	1	1	Installer Company Technician
Decreases In Water Level Problems	1		Plumber
Boring/Plumbing Issues	1	1	Plumber
Total	15	10	
No. of Issues resolved by Local User and Plumber	13		
No. of Issues resolved by Installer company technician	2		
Unresolved issues	10		

In areas where the installer company technician might not be readily available or where immediate attention is required, local technicians act as the first line of defence. Their contribution not only bridges the gap between professional services but also empowers the community by building technical capacity and reducing dependency on external support.

4.13.3. Functional Status of SWP

The study was carried out in altogether 3 districts – Chitwan, Morang and Jhapa with a total of 43 samples of SWPs. The results provide an overview of Solar Water Pump (SWP) installations across different years (Figure 20).

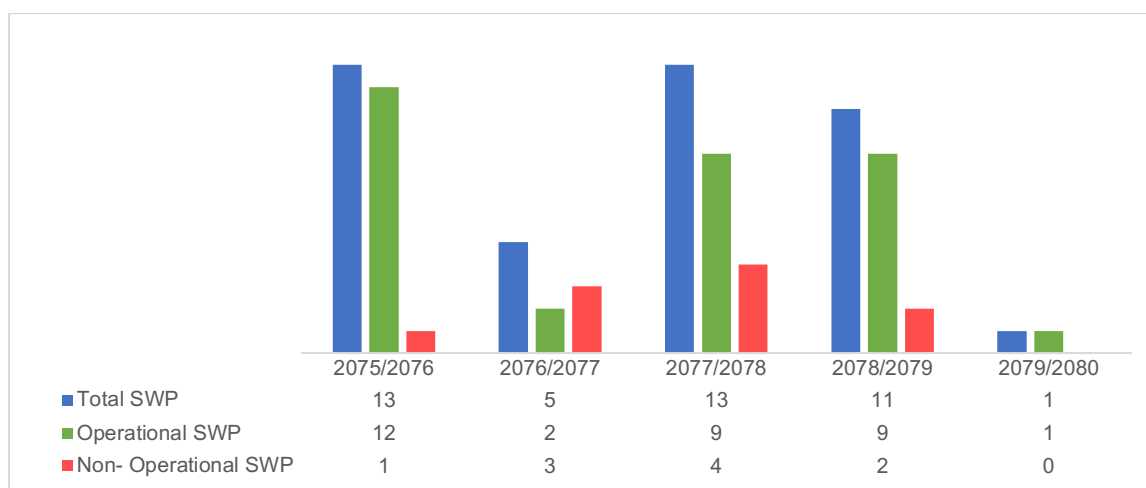


Figure 20: Operational and Non-Operational SWP in Varying Installation Years

This distribution indicates that out of surveyed 43 SWP systems, 33 systems are operational while 10 systems are not operational during the survey period. The observed increase in non-operational SWP systems in the surveyed region from 2075 B.S. to 2078 B.S. may be attributed to the use of cheaper products driven by increasing competition and a lack of proper testing facilities for pumps.

4.13.4. Details of Non-Operational SWP

During the field survey period, altogether 10 SWPs were found non-functional. Out of 10, 6 SWP from Chitwan, 3 SWP from Morang and 1 SWP in Jhapa were found not in operation. Table 5 depicts the reasons for the non-functional of the respective SWPs.

Table 5: Non-Operational SWPS

SWP List	Districts	Installation Year (B.S.)	Reason	More Details on Issues
SWP 1	Morang	2075/2076	Controller issues	The controller was damaged by lightning.
SWP 2	Chitwan	2076/2077	Mounting structure issues	The wind blew away the mounting structure. The system is dismantled and stored.
SWP 3	Morang	2076/2077	Controller issues	The controller was damaged by lightning. Sent for repair.
SWP 4	Morang	2076/2077	Controller issues	The pump was retained indoors due to controller issues. Awaiting repair.
SWP 5	Chitwan	2077/2078	Controller issues	Problem with controller settings.

SWP 6	Chitwan	2077/2078	Boring/Plumbing issues	Boring shifted due to road expansion. The pump had to be reinstalled.
SWP 7	Chitwan	2077/2078	Pump theft	The pump was stolen and not yet recovered.
SWP 8	Jhapa	2077/2078	Motor operational issue	The motor switches off within 30 seconds. The controller settings were checked but the motor issue persists.
SWP 9	Chitwan	2078/2079	Motor ON/OFF switch malfunction	The motor ON/OFF switch in the controller malfunctioned.
SWP 10	Chitwan	2078/2079	Motor operational issue	The motor runs for 30 seconds during peak sunshine hours and switches off. Works fine in reduced sunlight.

The table underscores that the most common unresolved issues were related to controllers, followed by motor issues. Occasional challenges were also noted with mounting structures, boreholes, and plumbing. Furthermore, there was one reported incident of pump theft. These findings emphasize the need to prioritize solutions for controller and motor issues to maintain the reliability of SWP systems, while also taking into account structural and environmental factors.

4.13.5. Communication Channel for Reporting issues

When reporting issues with SWP systems, 60% of users prefer local agents, 37% contact local technicians, and only 2% report directly to the installer company (Figure 21). Awareness of the installer company is limited, with local agents and technicians being the primary points of contact for issue reporting.

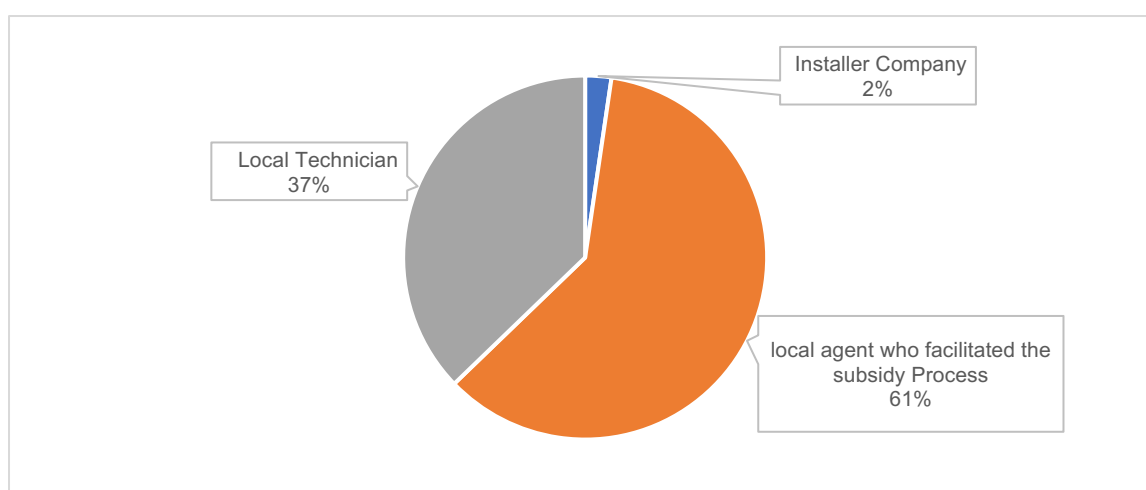


Figure 21: Communication Channel for Reporting Issues

4.13.1. Cost of past repair and maintenance

Survey results on SWP system repair and maintenance costs show that 28 respondents encountered no repair expenses, indicating system reliability. Thirteen reported costs below NPR 1,000, likely related to minor and cost-effective issues, while one respondent had expenses ranging from NPR 1,000 to 5,000, possibly indicating slightly more complex

problems (Figure 22). Another respondent reported repair costs exceeding NPR 5,000, highlighting the occasional need for higher expenditures to address intricate issues. Overall, the majority either experienced no repair needs or incurred costs below NPR 1,000, underscoring the cost-effectiveness of SWP system maintenance.

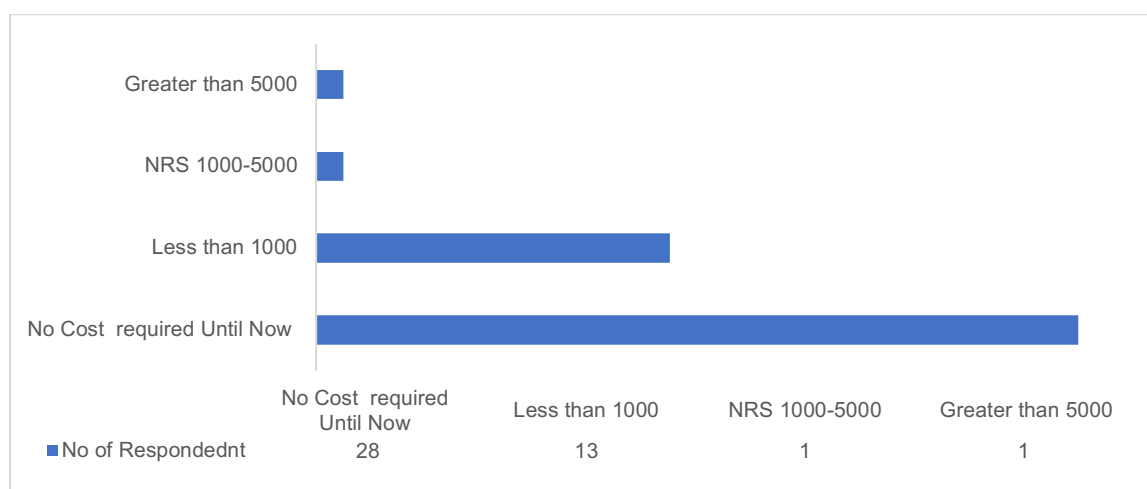


Figure 22: Past Repair and Maintenance Cost

4.14. Overall Satisfaction with SWP technology

Users when inquired about their satisfaction level with SWP technology. They were presented with the following table to assess the satisfaction level and their reasons.

Table 6 Categorisation of Satisfaction Levels

Fully Satisfied	Partly Satisfied	Totally Unsatisfied
If fully satisfied, what are the reasons? a. Trouble-free operation of the system b. Timely service by technician c. Economic benefit d. Environmental benefits e. Health benefits f. Workload reduction	If partly satisfied, what are the reasons? a. Difficult to operate b. Often encounter technical problems c. Technicians were not available on demand d. Dependent on sun e. More added work	If totally unsatisfied, what are the reasons? a. The system has failed, it doesn't work at all b. Very difficult to operate c. Often encounter technical problems d. Technicians were not available on demand e. Dependent on sun f. More added work

In a survey of 43 SWP users, 86% expressed complete satisfaction with SWP technology, citing trouble-free operation, economic benefits, environmental advantages, health impacts, and reduced workload (Figure 23). None mentioned timely service as a factor. Twelve percent expressed partial satisfaction, with concerns about technical problems, technician availability, and sun dependence. Only 2% were completely dissatisfied, citing system failure and technician support. Generally, SWP technology meets the majority's expectations, with room for improvement in service responsiveness and technical issues for a minority of users.

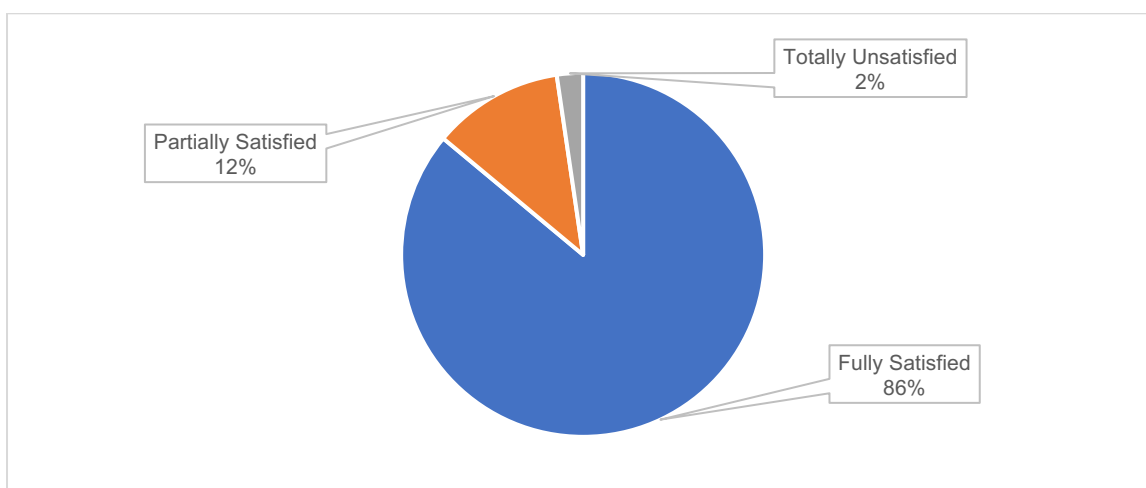


Figure 23: Overall Satisfaction of SWPs

4.15. Impact of SWPs on Agriculture Production and Income Generation

The responses provided by the surveyed participants reveal a diverse range of impacts that the SWPs has had on their income-generating activities and agricultural production. These impacts vary in terms of both positive changes and challenges faced.

4.15.1. Increase in Agricultural Production

Many respondents reported increased agricultural production following SWP implementation, attributing it to reliable irrigation water access for crops like paddy, maize, and mustard. Some mentioned doubled paddy production and effective use of previously uncultivated land. It's important to note that these claims are based on farmers' perceptions and self-reports, lacking specific quantitative data for validation.

4.15.2. Shift in Cropping Patterns

Several participants, 7 out of 43, indicated a shift in cropping patterns. They transitioned from cultivating crops for two seasons to three seasons, allowing for more diverse cultivation throughout the year. This shift is particularly notable in the case of paddy cultivation, which was traditionally restricted to the rainy season but now extends to two seasons.

4.15.3. Enhanced Cropping Diversity & Barren land Utilization

The availability of the SWP has enabled respondents to diversify their crops. 3 SWP users out of 43 informed that their previously barren land is now utilized for cultivation, contributing to a more varied crop output. This diversification includes not only staple crops like paddy, maize, and mustard but also commercial vegetation.

4.15.4. Transformation of Agricultural Practices

The SWP has brought about a transformative change in agricultural practices for some, 2 out of 43 respondents. Land that was previously limited to grass cultivation

due to water scarcity is now utilized for paddy, maize, and mustard cultivation. This transformation has led to increased agricultural productivity.

4.15.5. Decreased Reliance on Diesel Generators and Reduced Energy Bills

A recurring benefit mentioned by 21 out of 43, respondents, was the reduction in energy bills due to the SWP. This reduction is attributed to the decreased reliance on diesel generators, especially during daytime operations. Although the exact amount of savings varies, respondents consistently highlighted this positive financial impact. This shift signifies the SWP's role in reducing the consumption of fossil fuels and promoting more sustainable energy sources.

4.15.6. Uncertainty in Energy Savings

Several respondents mentioned experiencing reduced energy bills due to the implementation of the SWP. However, it was challenging for them to provide a precise estimate of the energy savings. This was primarily because some respondents owned larger land holdings than what the installed SWP capacity could efficiently cover. As a result, they still needed to rely on a combination of technologies to irrigate their entire land, making it difficult to accurately assess the energy savings from the SWP alone.

4.15.7. Challenges and Inactivity

Despite the observed positive impacts, some respondents pointed out specific challenges. A notable challenge is the intermittent inactivity of the SWP during certain months, as it operates exclusively when sunlight is available. This inactivity is linked to factors such as maintenance challenges, seasonal fluctuations, or uncertainties about repair services. During these periods of inactivity, the advantages of improved irrigation are temporarily limited. Additionally, due to the intermittent nature of the SWP, users have to rely on alternative irrigation methods when the SWP cannot operate, further emphasizing the need for diversified options. In response to this challenge, several respondents expressed interest in hybrid systems that can operate both on solar power and the national grid, providing more consistent and reliable irrigation capabilities.

4.15.8. Waiting for Repair

Several respondents opted to switch back to using AC motors instead of the SWP due to various issues related to the SWP technology, such as concerns about the strength of the mounting structure and controller malfunctions, among others. These challenges underscore the significance of having timely and easily accessible repair services in place to ensure the reliable and continuous operation of the SWP.

The implementation of the SWPs has brought about significant positive changes in income-generating activities and agricultural production for the surveyed participants. Increased access to water for irrigation, reduced energy bills, enhanced cropping diversity, and transformative changes in agricultural practices are among the key impacts observed. However, challenges such as inactivity during certain months and the need for efficient repair services highlight areas for improvement. The SWP's role in shifting cropping patterns

and reducing reliance on diesel generators also underscores its contribution to sustainable agricultural practices.

The combined use of AC and SWP pumps is expected to grow further, thanks to government subsidies and expanding electrification efforts. The Nepal Government promotes the use of subsidized agricultural AC energy meters. With many previously unelectrified areas gaining access to electricity, there's a need for a comprehensive approach. This involves integrating SWP systems with the grid and considering hybrid systems that work with both DC and AC sources. This approach optimizes SWP usage and ensures reliability as remote areas connect to the grid. Grid integration allows power import during low solar energy periods, guarantees uninterrupted pumping, and enables surplus energy export during peak times, improving overall efficiency and grid stability. **In a nutshell, grid integration and hybrid operation are crucial for maximizing SWP systems' potential, especially in areas with expanding electrification.** These approaches ensure a reliable water supply and adapt to evolving energy landscapes, making SWP systems more dependable and prominent in the coming days.

4.16. Assessment of willing to Pay for Services

4.16.1. Willingness to Pay for After-Sales Service of SWP Systems

When asked about their willingness to pay for after-sales service for their SWP systems, all 43 respondents expressed full support. They indicated their readiness to incur costs for services that ensure the maintenance and proper functioning of their solar water pump systems. This collective willingness underscores the value placed on reliable and efficient operation, highlighting the users' commitment to sustaining the benefits of the technology.

4.16.2. SWP User Preferences for After-Sales Service Packages

In the survey, users were presented with three distinctive after-sales service packages and were asked to share their preferences. The three packages with their distinctive features presented to SWP users are given in [Table 7](#).

Table 7: After-Sales Service Packages

Annual Maintenance Contract (AMC) Package	Based on the visit package	Existing package with more frequent visit provision
a. Regular preventive maintenance visits are scheduled annually b. Priority response time for any service requests c. Comprehensive system check-ups and performance evaluations during each visit d. Free replacement of faulty parts within the contract period e. Discounted rates for additional services or repairs outside the contract scope	a. On-demand visits as per customer's request b. Flexible scheduling of visits based on customer's availability and needs c. Standard system check-ups and performance evaluations during each visit d. Discounted rates for parts and labour during the visit e. Additional services or repairs are provided at a separate cost	a. Upgrade to the existing package with increased visit frequency b. Additional visits scheduled throughout the year for enhanced system maintenance c. Thorough inspections, cleaning, and calibration during each visit d. Free replacement of faulty parts within the contract period e. Priority response time for any service requests

The survey results provided valuable insights into the preferences of SWP users for after-sales service packages. The survey results revealed that among the after-sales service packages offered, the "Annual Maintenance Package" attracted 42% of SWP users ([Figure](#)

24). "Based on Visit Package" was preferred by 56% of participants, and the "Existing Package with More Frequent Visit" option garnered interest from 2% of users. **Based On Visit Package** appeared as the preferred choice for the majority, with 56% of respondents expressing their inclination.

The survey inquired if respondents were willing to pay for after-sales services and asked about their preferred payment range. The results revealed a unanimous trend among respondents:

- **Preference for Affordability:** All respondents (100%) expressed their preference for the "Less than NPR 1,500" option across all selected service packages.

Moreover, an intriguing pattern emerged in terms of willingness to pay within the preferred range for each package:

- **Annual Maintenance Package (AMC):** Respondents willing to pay between NPR 400 and NPR 1,500.
- **Based On Visit Package:** Respondents showed interest in paying between NPR 100 and NPR 1,000 for each visit as needed.
- **Existing Package with More Frequent Visits:** One respondent indicated their willingness to pay NPR 500.

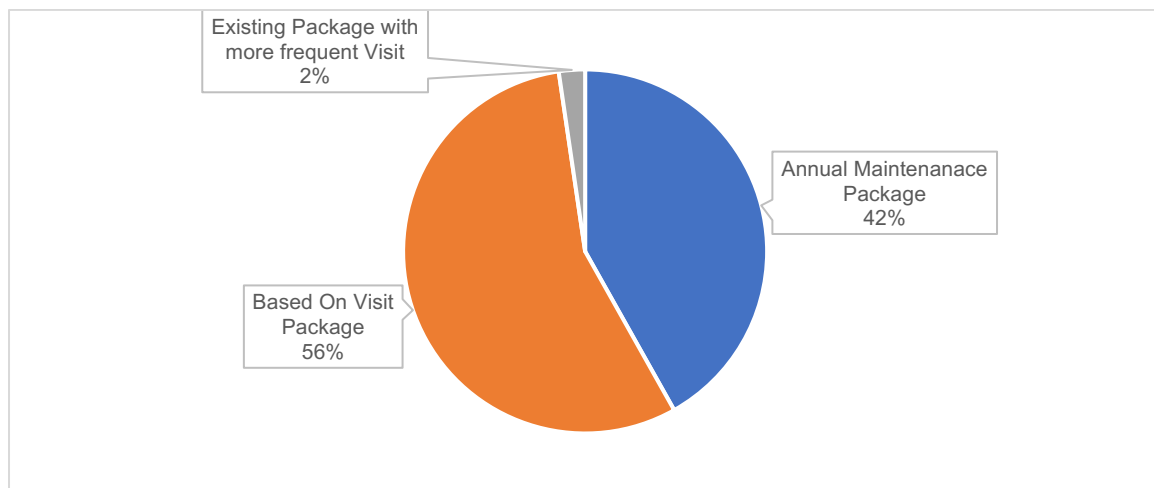


Figure 24: Selection of Packages

5. Survey Findings for Potential Enterprises

The enterprises were surveyed across different districts and municipalities, providing insights into their interest in engaging with the initiative (see Annexe II for the list of enterprises surveyed and Annexe IV for the questionnaire). The total 20 surveyed enterprises are located across districts such as Chitwan, Sunsari, Morang, and Jhapa, which are in proximity of the preidentified cluster showcasing a diverse geographical spread of interest in the SWP Survey Network.

5.1. Enterprises Characteristics & Existing Services

5.1.1. Registration Status of Enterprises

The surveyed enterprises were categorized based on their registration status. Out of the 20 surveyed enterprises, 15 were registered as Pvt. Ltd. Companies having Permanent Account Number (PAN), 3 were registered companies without PAN, and 3 were unregistered entities (Figure 25).

Notably, among the three unregistered enterprises, 2 consist of local-level technicians offering immediate repair and maintenance services to SWP users in their vicinity within their respective localities and the remaining one is the well-known pump technician of Damak with high-level expertise in repair and maintenance of both AC and DC water pumps.

The years of operation for the surveyed enterprises range from a minimum of 2 years to a maximum of 30 years. The average years of operation among the surveyed enterprises is approximately 14.1 years.

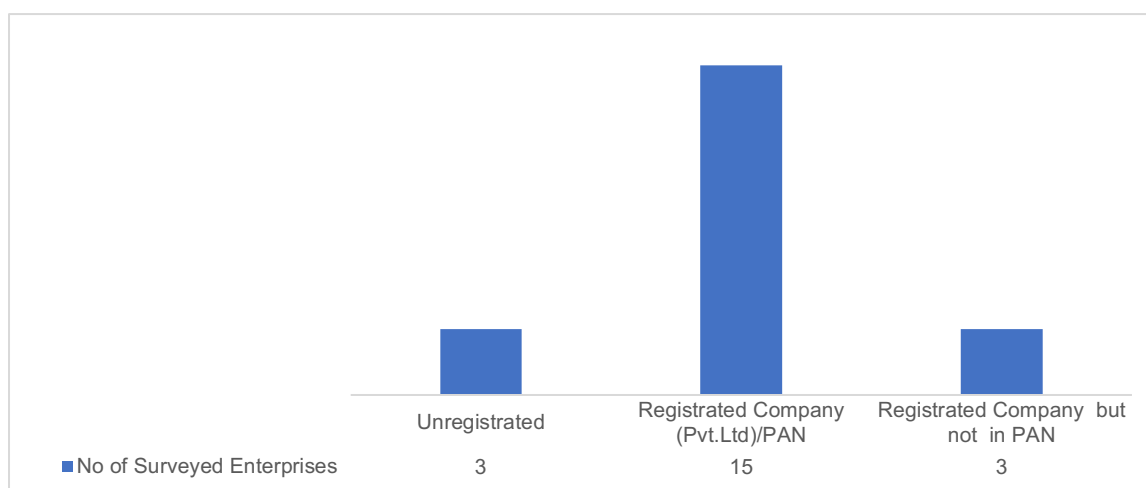


Figure 25: Registration Status

5.1.2. Type of Business Activities

The surveyed enterprises were categorized based on their type of business activities. Among the surveyed enterprises, 12 were identified as Electrical Repair Shops, 6 were General Repair Shops, and 2 were Local Technicians (Figure 26). No Bike Workshops were surveyed.

This distribution provides insights into the diversity of businesses considered in the survey, with Electrical Repair Shops being the most prominent category.

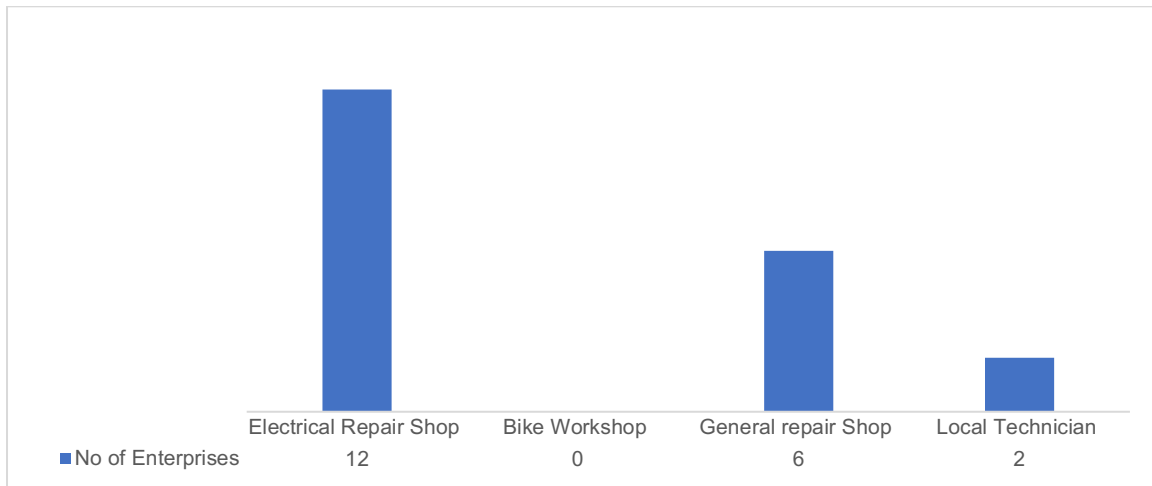


Figure 26: Current Business Activities

5.1.3. Type of Current Offered Services

The surveyed enterprises were asked about the types of services they offered. The results showed that 15 enterprises provided Repair and Maintenance of Equipment and Appliances, 19 enterprises offered Installation of Equipment/Appliances, 20 enterprises specialized in Technical Troubleshooting and Diagnostics, and 13 enterprises provided services related to Upgrades and Modifications of equipment (Figure 27). These findings reflect a comprehensive range of services, indicating a diverse skill set among the surveyed enterprises.

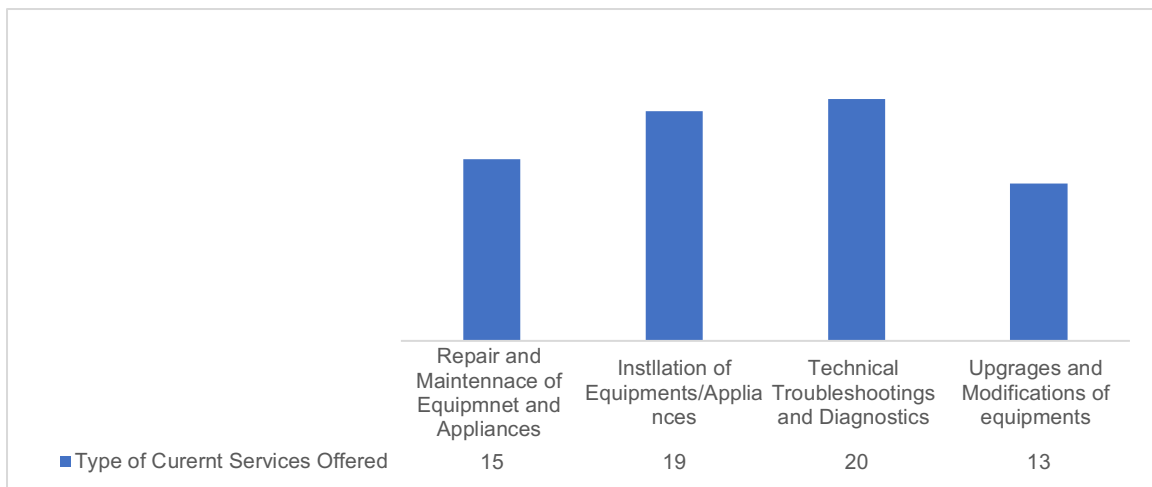


Figure 27: Current Offered Services

5.1.4. Scope of Work Presently Undertaken categorized in Domains

The scope of services provided by the surveyed enterprises showcases a diverse range of expertise areas, reflecting their specialization and capacity to address various technical needs. Here's a breakdown of the services under the different categories:

- **Electrical Services (13 enterprises):** Among the surveyed enterprises, 13 enterprises were currently offering electrical equipment-related services. The enterprises in this category have expertise in various electrical tasks such as house

wiring, motor repair, installation of solar home systems, and sales of electrical appliances.

- **Electronics Services (6 enterprises):** The enterprises in this category specialize in electronic tasks including repair and maintenance of online UPS, stabilizers, speakers, fridges, amplifiers, and more. With each enterprise having its electronics expertise, there are a combined total of 8 electronics skills across all enterprises.
- **Plumbing/Mechanical Services (8 enterprises):** Enterprises in this category excel in mechanical and plumbing tasks like AC submersible motor installation, repair & maintenance of AC motor parts like winding, bearings, water seal and so on. There are a total of 8 enterprises who were currently carrying out this.
- **Civil Skills:** None of the surveyed enterprises are currently engaged in any sort of civil construction work.

As per Figure 28, it's evident that most majority of the enterprises possess one skill mostly electrical. In addition, it's rare to find enterprises with expertise in all three domains.

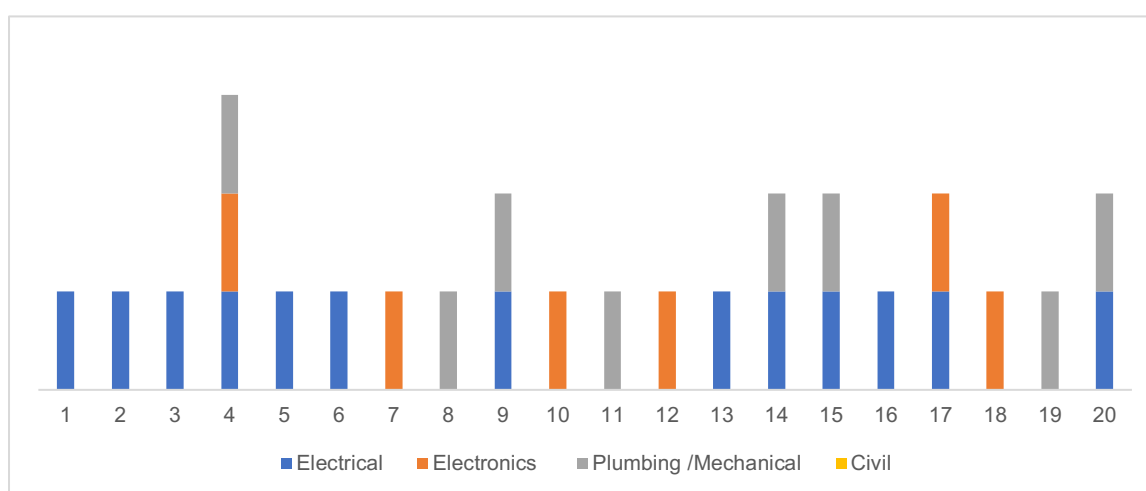


Figure 28: Combined Skills Set of 20 Enterprises

5.1.5. Affiliations and Partnership

During the survey, enterprises were asked about affiliations and partnerships in their service offerings. Among the responses:

- **Company Appointed Dealer:** 2 out of 20 surveyed enterprises, primarily involved in selling and installing AC water pumps, have been appointed as official dealers by various companies. This designation grants them exclusive rights within specific regions or market segments to distribute and sell particular products.
- **Company Authorized Repair Centre:** 1 out of 20 surveyed enterprises currently providing repair and maintenance services for Luminous inverters, has been recognized as an authorized repair centre by a company. This designation signifies their expertise and trustworthiness in conducting repairs on behalf of the company.
- **Franchise:** None of the surveyed enterprises operate under a franchise model, which involves using a franchisor's established business model, brand, and support systems in exchange for royalties or fees.

In summary, among the 20 surveyed enterprises, 2 have experience as company-appointed dealers, 1 as an authorized repair centre, and none as franchisees. These findings indicate a

limited presence of company-appointed dealerships, authorized repair centres, and franchises at the local level, suggesting relative scarcity in such affiliations and partnerships within the surveyed area.

5.1.6. Mode of Requesting Services

During the survey, when the enterprises were asked about how their services are rendered, the following responses were obtained:

- **Walk-in Customers:** All 20 out of 20 surveyed enterprises mentioned that they receive service requests from walk-in customers. This indicates that customers physically visit the enterprises' premises to request the services they need.
- **Phone Calls:** 18 out of 20 enterprises stated that they receive service requests through phone calls. This means that customers contact the enterprises via phone to inquire about services, schedule appointments, and request assistance.
- **Online Service Request:** None of the 20 surveyed enterprises reported receiving service requests through online platforms. This implies that customers are not currently using websites or online forms to submit service requests.
- **Mobile Application for Service Booking:** Similarly, none of the surveyed enterprises indicated that they receive service requests through mobile applications designed for booking services. This suggests that the use of dedicated mobile apps for service booking is not prevalent among these enterprises.

The findings from the survey highlight that the primary modes of requesting services are through walk-in visits and phone calls. While online service request platforms and mobile applications are not currently utilized by the surveyed enterprises, the information underscores the importance of in-person and phone-based communication for service delivery in this context.

5.1.7. Delivery of Services

When it comes to the delivery of services, the surveyed enterprises employ the following approaches:

- **On-site Service at Customers' Location:** 2 out of 20 enterprises provide services directly at the customers' locations. This means that their technicians travel to the customers' premises to diagnose and resolve issues on-site.
- **Workshop-Based Service at the Enterprises' Facility:** 5 out of 20 enterprises offer workshop-based services at their own facilities. This indicates that customers are required to bring the equipment or products in need of repair to the enterprise's workshop.
- **Both On-site and Workshop-Based Depending on the Nature of the Issue:** The majority, which is 13 out of 20 enterprises, follow a flexible approach. They offer both on-site services and workshop-based services, depending on the nature of the issue. This allows them to address a wide range of scenarios effectively.

This mix of service delivery methods ensures that the surveyed enterprises can cater to different types of service requests and issues, offering convenience and flexibility to their customers.

5.1.8. Adopted Transportation Methods

Regarding the mode of transportation for equipment, materials, or goods, the surveyed enterprises utilize the following methods:

- **We Have Our Own Dedicated Transportation Fleet:** 6 out of 20 enterprises have their own dedicated transportation fleet. This indicates that these enterprises maintain their vehicles to handle the transportation of equipment, materials, or goods.
- **We Rely on External Transportation Services:** 4 out of 20 enterprises depend on external transportation services. This implies that they engage third-party transportation providers to handle the movement of their equipment and materials.
- **We Have Limited Transportation Resources:** 10 out of 20 enterprises have limited transportation resources. This suggests that they might have some means of transportation, but it's not a fully dedicated fleet.

This distribution of transportation methods reflects the diversity of how surveyed enterprises manage the logistics of moving equipment, materials, or goods, allowing them to adapt to their specific operational needs.

5.1.9. Coverage Area of Enterprises

The surveyed enterprises have varying degrees of coverage in terms of their service areas:

- **Local Coverage (Within a specific city or town, up to 10 km):** 9 enterprises primarily serve customers within their immediate vicinity, offering services within a range of approximately 10 kilometres from their location. This indicates a focus on catering to the needs of their local community.
- **Regional Coverage (Covering multiple cities or towns in a specific region, 10-50 km):** 6 enterprises extend their services to a broader area, covering multiple cities or towns within a specific regional radius of 10 to 50 kilometres. This suggests a willingness to reach customers beyond their immediate locality.
- **Districts-Level Coverage (Covering an entire district, 50-100 km):** 5 enterprises provide coverage at a district level, encompassing a larger geographical area that ranges from 50 to 100 kilometres. This level of coverage indicates a capacity to serve a wider customer base within an entire district.
- **Provincial Coverage (100-500 km):** None of the surveyed enterprises operate at a provincial level, which implies that their services are not extended to cover an entire province, indicating a more localized operational scope.

Overall, the distribution of coverage among the surveyed enterprises reflects their varying reach and capacity to cater to customers across different geographical ranges.

5.1.10. Capacity for Handling Projects

The surveyed enterprises exhibit varying capacities to handle projects or service requests simultaneously:

- **Up to 5 projects or service requests:** 14 enterprises are equipped to manage a workload involving up to 5 projects or service requests concurrently. This indicates their ability to efficiently allocate resources and address multiple tasks simultaneously.
- **Up to 5-10 projects or service requests:** 6 enterprises have a slightly higher capacity, capable of handling between 5 to 10 projects or service requests

concurrently. This demonstrates their organizational efficiency and flexibility in managing a larger workload.

- **More than 10 projects or service requests:** None of the surveyed enterprises reported the capacity to handle more than 10 projects or service requests simultaneously. This suggests that they tend to focus on a manageable number of tasks to ensure quality and timely service delivery.

5.1.11. Equipment and Tools

When asked about their equipment and tools for providing services, the surveyed enterprises responded as follows:

- **Specialized Equipment:** 1 enterprise stated that they possess specialized equipment tailored for their specific services.
- **General-Purpose Tools:** 9 enterprises indicated that they utilize general-purpose tools for their service delivery.
- **A mix of Specialized and General-Purpose Tools:** 10 enterprises reported using a combination of specialized and general-purpose tools to effectively meet a range of service requirements.

5.1.12. Warrantee/Guarantee Provision

When questioned about whether they provide guarantees for their services or products, the surveyed enterprises responded as follows:

- **Affirmative:** All 20 enterprises confirmed that they do indeed offer guarantees for their services or products.
- **Negative:** None of the enterprises stated that they do not provide guarantees.
- **Conditional:** The enterprises indicated that the offering of a guarantee depends on the specific service or product under consideration.

5.1.13. Assurance of Products

When asked about their methods for ensuring the quality of their services or products, the surveyed enterprises responded as follows:

- **Regular Quality Checks and Inspection:** None of the enterprises indicated that they utilize regular quality checks and inspections.
- **Adherence to Industry Best Standards and Practices:** None of the enterprises mentioned that they follow industry-leading standards and practices to uphold quality.
- **Customer Feedback and Satisfaction Surveys:** All 20 enterprises emphasized their reliance on customer feedback and the implementation of satisfaction surveys as a means to guarantee the quality of their services or products.

5.1.14. Payment Methods

Payment for services among the surveyed enterprises is structured as follows:

- **One-Time Payment for Each Service Request:** All 20 enterprises indicated that they accept one-time payments for each service request.
- **Long-Term Service Contracts and Periodic Payments:** None of the enterprises reported offering long-term service contracts with periodic payments.

- **Payment Based on the Type and Complexity of the Service Provided:** All 20 enterprises mentioned that their payment structure is based on the type and complexity of the specific service provided.

5.2. Knowledge and Experience with SWP Systems

In our comprehensive survey, we delved into three critical aspects to gain a deeper understanding of how the surveyed enterprises engage with SWP systems. We also explored the extent of services they offer related to SWPs and their comprehension of SWP technology.

5.2.1. Familiarity with SWP Systems

When asked about their familiarity with SWP systems, the responses revealed that among the 20 surveyed enterprises, 8 enterprises indicated that they are familiar with SWPs. This suggests that a portion of the enterprises has prior exposure or knowledge about this technology, while the remaining 12 enterprises lack familiarity with SWPs.

5.2.2. Provision of Services Related to SWPs

Regarding the provision of services related to SWP systems, the findings indicated that out of the 20 surveyed enterprises, 6 enterprises offer services connected to SWPs. This subset of enterprises is ready to address the demands of SWP technology. Conversely, 14 enterprises do not presently provide such services, possibly focusing on different areas of expertise.

5.2.3. Understanding of SWP Technology

To assess their understanding of SWP technology, the enterprises were asked to self-assess their knowledge level. Interestingly, none of the enterprises claimed to have expert knowledge. Among the responses, 13 enterprises acknowledged having limited knowledge about SWP technology. In contrast, 6 enterprises stated a moderate level of understanding, while only 1 enterprise claimed to possess advanced knowledge in this domain.

5.2.4. Participation in Formal Training for SWP Technology

In the course of the survey, one of the aspects explored was whether the surveyed enterprises had undergone formal training on SWP technology. Out of the 20 participating enterprises, none of them reported having attended formal training specifically focused on SWP technology.

These insights provide a comprehensive view of how the surveyed enterprises interact with SWP systems, their service offerings, and their grasp of the underlying technology. The diversity in responses underscores the range of experiences and expertise present within this group of businesses.

5.3. Anticipated Challenges in Joining the Survey Network

The challenges anticipated by enterprises when providing repair and maintenance services for SWP systems vary in their perceived significance. Foremost among these concerns is the difficulty of accessing essential spare parts and components, with 14 enterprises highlighting this as a major issue (Figure 29). Ensuring a reliable supply chain for these

components is deemed critical. Close behind is the limited availability of technical personnel within their networks, a concern raised by 11 enterprises, underlining the essential role of a skilled workforce in maintaining service quality. Nine enterprises expressed concern about the lack of local awareness and demand for SWP services, indicating a need for targeted marketing and education efforts. Seven enterprises emphasized the importance of comprehensive training and capacity building to address the technical expertise gap. Five enterprises expressed apprehension about the high initial investment required to establish the SWP repair and maintenance network, underlining the financial commitment involved. While some enterprises mentioned resource and infrastructure shortcomings, specific details were not provided. Nevertheless, three enterprises expressed confidence in their ability to effectively manage potential challenges. Prioritizing these concerns based on the number of responses is pivotal for ensuring the success of SWP repair and maintenance services and promoting the broader adoption of SWP systems in communities.

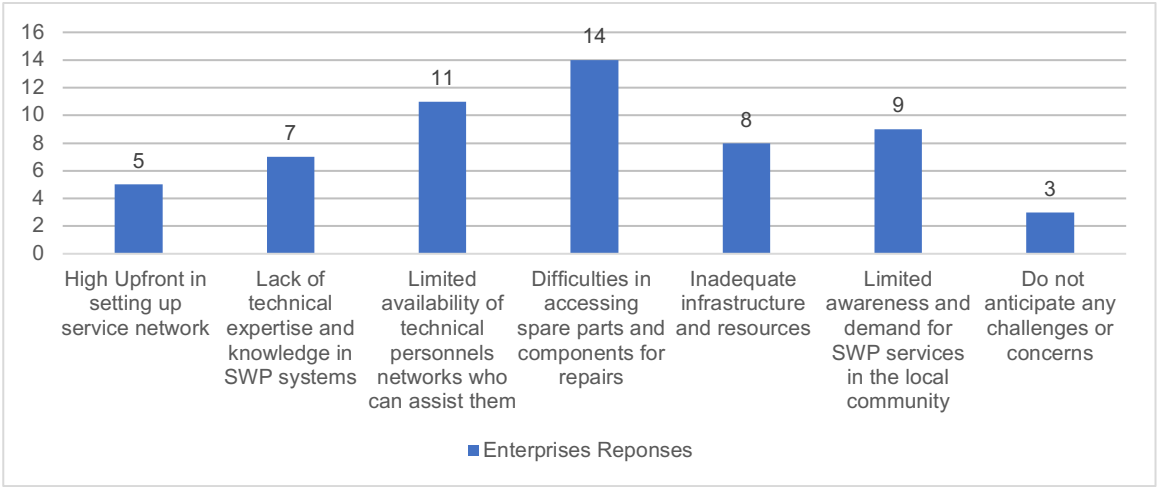


Figure 29: Anticipated Challenges

5.4. Essential Prerequisites for Engaging in the Survey Network

The survey conducted inquired about the specific prerequisites that enterprises deem necessary to actively participate in the survey network for SWPs. The results of the survey shed light on the key priorities and requirements that these enterprises consider essential for their involvement in the network.

At the forefront of these prerequisites is the establishment of a knowledge-sharing platform, which emerged as the top priority among surveyed enterprises. A significant 19 enterprises expressed a strong need for such a platform, emphasizing its significance as a hub for collective learning and sharing best practices (Figure 30). This underscores the importance of knowledge exchange within the network, as participants recognize the value of shared insights and experiences in advancing their understanding and capabilities in the solar water pump industry.

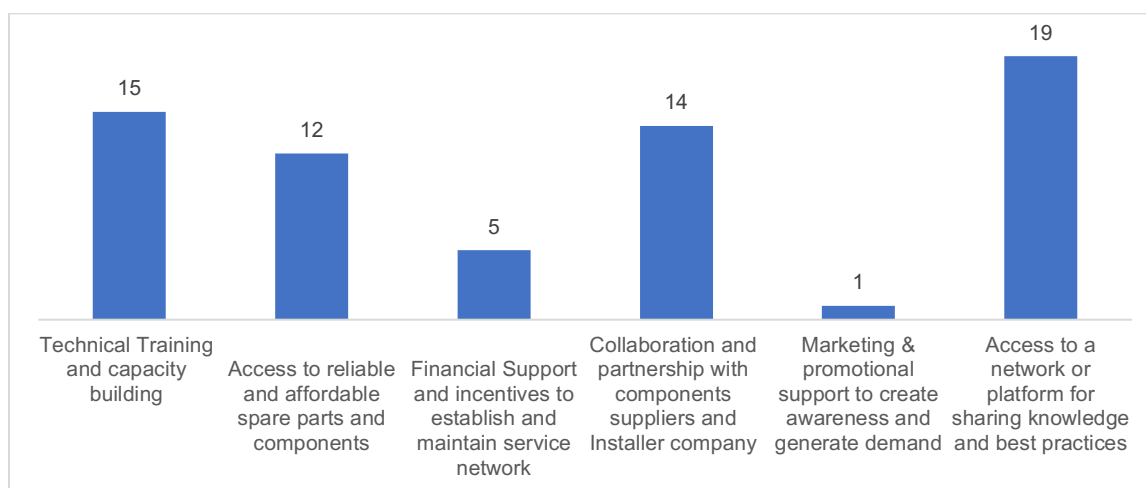


Figure 30: Prerequisites for Enterprises

Following closely in priority is the requirement for technical training and capacity building. Fifteen enterprises highlighted the importance of enhancing technical skills and knowledge as a prerequisite for participation. This reflects the understanding that a well-trained and skilled workforce is crucial for effectively operating and maintaining SWP systems, ensuring their longevity and efficiency.

Collaborative partnerships with component suppliers and installers also emerged as a critical prerequisite, as recognized by 14 enterprises. This underscores the importance of strong relationships and cooperation within the supply chain. Such partnerships are vital for securing the necessary components and ensuring seamless installation and maintenance, which are essential for the success of SWP projects.

Access to reliable spare parts and components is another fundamental prerequisite, with 12 enterprises emphasizing its importance. This requirement ensures that participants have access to the necessary resources for maintaining and repairing SWP systems, minimizing downtime and disruptions.

In contrast, financial support and incentives were of lower priority, with only 5 enterprises expressing a need for such assistance. This suggests that while financial support is appreciated, it may not be the primary focus for most participants in the survey network. Similarly, marketing and promotional support ranked the lowest in terms of emphasis, mentioned by just one enterprise, indicating that enterprises may prioritize technical and operational aspects over marketing efforts.

In summary, the prioritization of these prerequisites underscores the enterprises' strong focus on knowledge exchange, skill development, and collaboration with suppliers and installers as quintessential factors for the success of the survey network for solar water pumps. These prerequisites collectively contribute to building a sustainable and effective network that can drive improvements in the SWP industry, benefitting both the participating enterprises and the broader community.

Addressing these prerequisites effectively will contribute to fostering a conducive environment for collaboration and growth.

5.5. Enterprises Willing to Participate in SWP Survey Network

In this section, we analyze the willingness of potential enterprises to participate in the SWP Survey Network based on the responses provided by 20 surveyed enterprises. The responses were categorized as "Yes" (indicating willingness to participate) and "No" (indicating no participation) based on the context of the survey.

Out of the total 20 enterprises surveyed, a substantial majority of 16, comprising 80%, demonstrated a strong willingness to participate in the Solar Water Pumping (SWP) Survey Network (Figure 31). This enthusiastic response reflects a significant interest in and alignment with the objectives of the survey network.

Among the surveyed enterprises, 20% (4) indicated a lack of willingness to participate in the SWP Survey Network. This decision is primarily attributed to their existing workload and scope, which are perceived as sufficient. This insight sheds light on the practical considerations of managing resources and commitments within these enterprises.

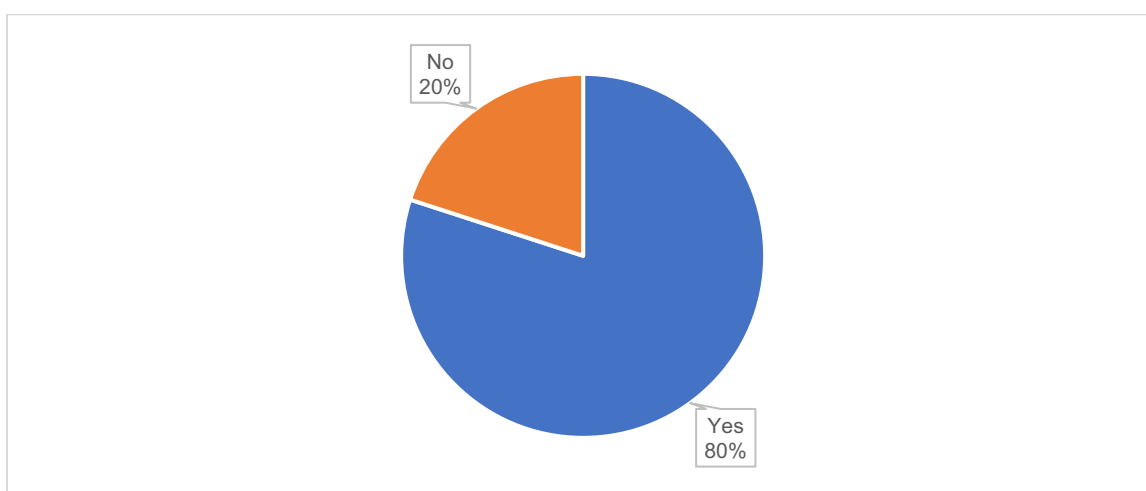


Figure 31: Willingness to Participate in SWP Survey Network

5.6. Potentially Suitable Enterprises Identified

The criteria considered for selecting enterprises are as below

- Willingness: Whether the enterprise is willing to participate in the project or task.
- House Wiring: Whether the enterprise has expertise in house wiring.
- SWP Troubleshooting: Whether the enterprise has experience in troubleshooting issues related to SWP systems.
- Motor Winding: Whether the enterprise has the capability to handle motor winding tasks.
- Controller Troubleshooting: Whether the enterprise can troubleshoot and repair controller issues.
- Years of Experience: The number of years of experience the enterprise has in the relevant field.
- Offer Services Related to SWP: Whether the enterprise offers services specifically related to SWP systems.
- Understanding of SWP: The level of understanding and knowledge the enterprise has about SWP technology.

- Workshop-Based/Field-Based/Both: Whether the enterprise operates from a workshop, works in the field, or offers services in both settings.

The aforementioned criteria have been carefully selected to serve as a comprehensive framework for identifying and evaluating potential enterprises for specific projects or initiatives. Each criterion addresses a specific aspect of an enterprise's capabilities, experience, and willingness, all of which are crucial factors in determining their suitability.

The **Table 8** below provides the list of the top 4 enterprises in both the surveyed regions based on the criteria listed above.

Table 8: Top 4 Identified Enterprises

Cluster name	Potential enterprises	Location	Distance from cluster (km) to market centre
Chitwan	A.S Electric Workshop	Bharatpur-27, Jeetpur Bazar	25
	Shiva Narayan Chaudhary	Khairanahani 5, Parsa Bazar	25
	Chitwan Solar Urja Centre	Bharatpur Bazar	5
	D-Electronics	Bharatpur-28, Jeetpur Bazar	25
Damak	Panasonic Electronics World	Damak Bazar	1
	Shrestha Electric Workshop	Damak Bazar	1
	Yogendra Dhakal	Ratutawamai-7, Morang	50
	Telekala Sourya Urja	Damak Bazar	2

6. Summary of Survey Findings and Recommendations

6.1. Summary of the SWP users

The survey of SWP users has provided valuable insights into their experiences, challenges, and preferences regarding the SWP technology. These insights offer a comprehensive view of the impact of SWP systems on agricultural practices and shed light on various aspects of user engagement.

- **Adoption and Impact:** SWP technology has significantly reduced users' reliance on diesel generators. The survey reveals that a majority of users now prefer utilizing either SWP alone or in conjunction with the AC grid for their irrigation needs. This shift reflects a substantial decrease in the use of diesel generators, underscoring the positive environmental and economic outcomes of SWP adoption.
- **Operational Status and Maintenance of SWP Systems:** A notable observation is that a significant 80% of the SWP systems, installed 2-3 years ago, are still operational. These systems have effectively undergone basic repair and maintenance as needed, showcasing their resilience and reliability.
- **Controller-Related Issues & Repair Challenges:** On the other hand, approximately 20% of the SWP systems faced challenges, with the majority of issues being linked to controllers. Difficulty in finding suitable repair services, coupled with the high cost of controller replacement, prompted some users to revert to using AC pumps for irrigation. The cost factor is especially significant in maintaining SWP systems and impacts users' decisions.
- **Capacity and Land Holdings:** A noteworthy observation is that many SWP users possess multiple land holdings, often exceeding the capacity of their SWP systems for irrigation. This suggests that a significant proportion of SWP users have relatively larger land holdings, reflecting a relatively affluent user base. Also, the installed SWP cannot suffice all their irrigation needs so they have to rely on other technologies as well to cater for all of their irrigation needs.
- **Need for Hybrid Operation and Grid Integration:** The survey highlights the need for hybrid operation integration in SWP. One of the significant concerns raised by the users was the need for a combination of technologies to facilitate irrigation. The majority of SWP users alternatively rely on AC pumps to support the SWP intermittency. The users inquired if instead of using two types of pumps they could use only SWP and integrate the grid into it to have reliable access to water in all weather conditions. In summary, the survey findings emphasize the urgency of hybrid operation and grid integration in SWP systems to address users' concerns and provide a more dependable water supply solution.
- **Challenges and Local Support:** The survey findings indicate that users often turn to local manpower to tackle minor issues. Local expertise is reached out to address minor issues like wiring faults, primarily due to its cost-effectiveness and rapid response. This highlights the importance of accessible local support in swiftly resolving issues, minimizing downtime, and ensuring uninterrupted pumping operations.
- **Need for Streamlined Services:** The survey highlights the significance of streamlined repair services and effective communication between users and installer companies. Improved access to repair services and better communication avenues emerged as essential needs, enabling users to promptly address technical issues and maintain reliable SWP operations.

- **User Prospects on Survey Networks:** The survey also explored the willingness of SWP users to participate in survey networks. Unanimously all respondents expressed their willingness for the need of the survey network. Users showed a preference for a practical approach – relying on local technicians for minor repairs and turning to enterprises for major issues. However, users also voiced a noteworthy concern – the selection of a single entity for all SWP tasks.

6.2. Summary of Enterprises Survey

The enterprise survey outcomes provide a great of insights into the perspectives, needs, and expectations of potential service provider enterprises within the SWP systems.

The key takeaway from the survey of enterprises in both Damak and Narayanghad market centres is that troubleshooting SWP systems requires expertise in multiple domains, including electrical, electronics, and plumbing. Only 1 out of 20 enterprises possesses all the necessary skills and knowledge to address the complete range of issues in these systems. Therefore, finding enterprises that specialize in and excel in all three domains is essential for effective troubleshooting and maintenance of SWP systems.

The results shed light on common challenges such as upfront costs, technical expertise gaps, and limited access to spare parts. These challenges underscore the importance of collaboration, technical training, and dependable access to essential components.

The survey delves into the specific prerequisites that potential service provider enterprises aim to fulfil for effective participation in SWP service networks. Technical training, availability of spare parts, financial backing, partnerships with component suppliers and installers, marketing assistance, and platforms for knowledge exchange were identified as crucial elements by respondents.

These findings deepen our comprehension of the primary hurdles which will be encountered by potential service providers and the essential elements necessary to establish a resilient service network. Addressing these challenges and meeting the identified requirements holds the potential to elevate the SWP ecosystem, resulting in enhanced service provision, greater adoption rates, and overall expansion within the sector.

It's also noteworthy that comprehensive servicing of SWP systems demands expertise in multiple domains, including electrical, electronics, and mechanical/plumbing. Remarkably, among the surveyed enterprises, one out of twenty possessed experiences across all three domains, highlighting the rarity and significance of such versatile capabilities.

6.3. Recommendations for the Initiative to Demonstrate Feasibility

Some recommendations for the initiative aimed at demonstrating the feasibility of a survey network for SWP systems

- **Create a pool of Local Technician Networks:** Given the preference of SWP users for local technicians for minor repairs, fostering a network of skilled local technicians is crucial. The initiative should focus on providing yearly technical training and capacity-building programs to empower local technicians to effectively address common issues.
- **Collaborative Repair Services:** To address the concerns raised by users regarding monopolistic practices also due to the constrained in finding single enterprises capable of catering to entire SWP issues, the initiative should encourage collaborations among multiple enterprises. This could prevent a single entity from gaining undue control over the market and ensure fair competition as well as more doable for the establishment of a service network.
- **Promote Local Enterprise Engagement:** Encourage local enterprises to specialize in SWP repair and maintenance services. Required technical support and other lucrative pathways could be provided to these enterprises, fostering a competitive and diverse service ecosystem.
- **Standardization of Costs:** To address the apprehensions related to service costs, the initiative could work towards establishing standardized pricing guidelines for various repair and maintenance services. This can enhance transparency and instil trust among SWP users.
- **Facilitate Spare Part Availability:** Address the challenge of limited access to spare parts by establishing partnerships with suppliers to ensure a steady supply. This can ensure timely repairs and reduce downtime for SWP users.
- **Establish Online Knowledge Sharing Platforms:** Create digital platforms where SWP users, local technicians, and enterprises can share experiences, best practices, and troubleshooting tips. This can build a collaborative community and provide solutions to common issues.
- **Engage with Users for Service Improvement:** Regularly gather feedback from SWP users to continuously improve the quality of services offered. This user-centric approach can lead to tailored solutions and enhanced user satisfaction.
- **Expand Outreach and Awareness:** Increase awareness about the benefits of SWP services through targeted marketing campaigns. This can stimulate demand and encourage users to participate in the survey network.
- **Explore Hybrid Service Models:** Investigate hybrid service models that combine the strengths of both local technicians and enterprises. This could provide users with a comprehensive service experience that balances convenience and expertise.
- **Monitoring and Evaluation:** Establish a robust monitoring and evaluation framework to assess the effectiveness of the survey network initiative. Regular assessment can help identify areas of improvement and ensure the initiative's success.

6.4. Conclusion

The most prominent output observed from the survey of the enterprises in both Damak and Narayanghad market centres is that only 1 out of 20 surveyed enterprises had expertise in all the domains (electrical, electronics, and plumbing) mostly required to troubleshoot the problems arising in any SWPs.

In addition to this, the majority of the enterprises operate from their shop or workshop to troubleshoot the issues. From the survey of enterprises, it can be inferred that a single enterprise cannot troubleshoot all the problems single-handedly. Thus, for the service network envisioned, a specialized solution should be devised in two layers:

1. Local Technician Training: Local technicians should be trained in minor repair and maintenance.
2. Specialized Service Network: Three enterprises with expertise in electrical, electronics, and plumbing should be trained on SWP systems and their components.

The layers are visualized in **Figure 32**.

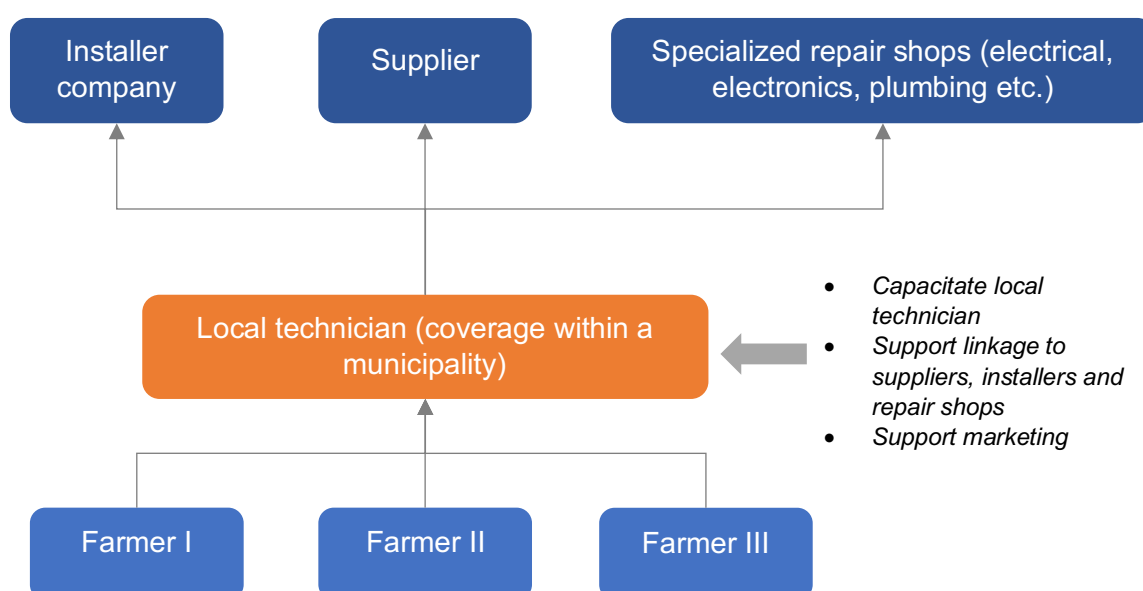


Figure 32: Two-Layer Specialized Service Solution

In this specialized service network, users will first reach out to local technicians for diagnosis of the actual issues. If the issues are beyond the scope of local technicians' capabilities, they will refer the user to either electrical, electronics, or plumbing enterprises depending on the nature of the issues.

Annexe I: Dense Municipalities & Nearby Market Centre

Table 9: Density of Municipalities and the Nearby Market Centre

S.N	Province	Districts	Municipality(Mun) /Rural Municipality(RM)	Installed SWP					Nearest Urban Centre/ Potential Clusters	Cluster Total	Selected Cluster
				FY 75	FY 76	FY 77	FY 78	Total			
1	Madhesh	Rautahat	Durga Bhagwati RM	51	7	3	5	66	Chandrapur, Rautahat		
			Fatuwabaijaipur Mun	19	25	7	6	57	Birgunj		
			Madhav Narayan Mun	24	3	10	7	44	Chandrapur, Rautahat		
2	Madhesh	Sarlahi	Malangwa Mun	25	2	1	4	32	Chandrapur, Rautahat		
			Chandranagar RM	23	5	0	3	31	Chandrapur, Rautahat	229	
			Ishworpur Mun	14	1	6	7	28	Chandrapur, Rautahat		
			Bagmati Mun	2	19	1	6	28	Chandrapur, Rautahat		
3	Madhesh	Parsa	Chhipharamai RM	47	19	0	10	76	Birgunj		
			Jirabhawani RM	2	18	8	2	30	Birgunj	236	
			Jagarnathpur RM	6	7	2	8	23	Birgunj		
4	Bagmati	Chitwan	Bharatpur Metro	5	14	22	21	62	Narayanghat	164	Cluster 1 for Survey
			Khairahani Mun	27	5	10	3	45	Narayanghat		
			Rapti Mun	24	7	2	6	39	Narayanghat		
5	Koshi	Morang	Ratuwamai Mun	39	30	11	2	82	Damak	167	Cluster 2 for Survey
			Katahari RM	13	0	5	7	25	Damak		
			Rangeli Mun	2	1	0	9	12	Damak		
6	Lumbini	Kapilvastu	Badganga Mun	0	22	8	4	34	Butwal	54	
			Buddhabhumi Mun	5	3	3	9	20	Butwal		
			Madhyabindu Mun	0	18	0	0	18	Narayanghat		
7	Madhesh	Bara	Simraungadh Mun	10	1	2	8	21	Birgunj		
			Mahagadhimai Mun	2	10	2	4	18	Birgunj		
			Kalaiya Sub-Metro	0	4	0	7	11	Birgunj		
8	Koshi	Jhapa	Gauradaha Mun	1	0	9	7	17	Damak		
			Baradashi RM	2	8	7	0	17	Damak		
			Shivasataxi Mun	5	0	5	4	14	Damak		

Annexe II: List of Surveyed Enterprises

Table 10: The List of Surveyed Enterprises

S.N	Name Of Enterprise /Individual	Name of Owner	Contact Number	Districts	Municipality	Ward	Tole/Bazar	Willing to participate in SWP Survey Network
1	Manoj Bijuli Pasal	Manoj Kumal	9817297776	Chitwan	Bharatpur	28	Jeetpur Bazar	Yes
2	Sagar Bijuli Pasal	Sagar Kumal	9826208915	Chitwan	Bharatpur	28	Jeetpur Bazar	Yes
3	D- Electronics	Dal Bahadur Magar	9811113704	Chitwan	Bharatpur	28	Jeetpur Bazar	Yes
4	A.S Electric Workshop	Jhanak Ram Chaudhary	9855054992	Chitwan	Bharatpur	27	Tilauli Bazar	Yes
5	ASR Stores	Ramesh Sharma		Chitwan	Bharatpur	27		No
6	Krishna Emporium	Deependra Thapa	9845090140	Chitwan	Bharatpur	27		No
7	Chitwan Solar Electronics Centre	Binaya KC	9845941211	Chitwan	Bharatpur	3	Sangam Road Narayanghad	No
8	Kanchan Concern	Kiran Dawadi	9845084588/9855054308	Chitwan	Bharatpur	3	Lions Chowk, Narayanghad	No
9	Shiva Narayan Choudhary	Shiva Narayan Choudhary	9845563570	Chitwan	Khairahani Mun	5	Khairahani Bazar	Yes
10	Chitwan Solar Urja Centre	Naresh Bahadur Thapa	9855055044	Chitwan	Bharatpur	12	Baratpur Bazar	Yes
11	Naba Durga Repairing and Sales Centre	Durga Prashad Sigdel	9842176081	Sunsari	Itahari	6	Itahari	Yes
12	Subidha Electronics	Him Prashad Bhattarai	9842241690 9801041690	Sunsari	Itahari	6	Itahari	Yes
13	Yogendra Dhakal	Yogendra Dhakal	9746881546	Morang	Ratuwamai	7	Copper Suka	Yes
14	Durga Electrics Works	Ghanshyam Rajbanshi	9816387210	Morang	Ratuwamai	4	Ambari	Yes
15	Surya Electronics Workshop	Surya bahadur Koirala	9842290241	Morang	Sijuwa	5	Sijuwa	Yes
16	Bibek Bijuli Marmat	Hari Prashad Khatiwada	9842229278	Morang	Aaitabare	5	Urlabari	Yes
17	Panasonic Electronics World	Manoj Kumar Singh	9804931639	Jhapa	Damak	13	Damak	Yes
18	Telekala Sourya urja	Shrawan Poudar	9852675117	Jhapa	Damak	6	Ratopul	Yes
19	Shrestha Electric Workshop	Raj kumar Shrestha	9815933549	Jhapa	Damak	4	Damak	Yes
20	Shree Shidda Devi Mill Machinery	Chetnath Sapkota	9852670915	Jhapa	Damak	10	Damak	Yes

Annexe III: Survey Questionnaire for SWP Users

1. BASIC INFORMATION

Form ID		Date	DD/MM/YY	Interviewer	Sadiksha	Location	
Province		District		RM/Mun		Ward	
GPS Coordinate		Latitude		Longitude			
SWP Owner Name				Female ☐	Male ☐	Age	
Respondent Name				Female ☐	Male ☐	Mobile No	

2. HOUSEHOLDS (HHs) CHARACTERISTICS

No of family Members					
Household Head	Male ☐		Female ☐		
Facilities	Toilet ☐	Drinking Water	Radio/Television	Grid ☐	All
Education Level	Illiterate Primary Level (1-5) ☐	Lower Secondary Level (6-8) ☐	Secondary Level (9-10)	Higher Secondary Level (11-12) ☐	Secondary level (12>) ☐
Occupation	Agriculture Business ☐ Labor Works ☐ Government Service ☐ Private ☐				

3. CROPPING PATTERNS

S. N	Crop	Water Requirements (Yes/No)	Growing – Harvesting Months
1.	Rice		
2.	Maize		
3.	Mustard		
4.			
	Vegetable		

4. ESTIMATED ANNUAL INCOME AND EXPENDITURES

Estimated Annual Income and Expenses			
Income	% of income	Expense	% of Expense
Rent		Rent	
Selling of Cattle		Land Leasing	
Agriculture production		Living Expense	
Income from Remittance		Celebration of Festivity	
Service jobs except remittance		Child Education	
Business Activities		Fertilizers	

5. TECHNICAL INFORMATION

Name of the Installer Company				
Land Holdings Kattha/ Biga		Land area irrigated by SWP		
Year of Installation	2076 ☐	2077 ☐	2078 ☐	2079 ☐
Is it in operation?	a. Yes ☐		b. No ☐	
Type of SIP	Submersible ☐	Surface ☐	Hybrid ☐	
Estimated Water Yield m3/day	10-50 m3	50 -1 lakh m3 ☐	More	No idea
Head, m	Depth Of Shallow Tube Well Borehole/Well			
Diameter Of Shallow Tube Well Borehole/Well				

SOLAR PV ARRAY AND MOUNTING STRUCTURES			
Parameters	Size/Characteristics	Remarks	
Total Installed PV Capacity(kWP)			
Types of Mounting structure/frames	Galvanized MS ☐	Painted MS ☐	Aluminum ☐
SOLAR WATER PUMPS AND CONTROLLER			
Type of pump	AC ☐	DC ☐	
Parameters	Size/Characteristics	Remarks	
Pump and controller make/models/brands			
Size/Type of pump controllers			
Status of pump controller			
Do you have remote monitoring system installed?		Yes ☐ No ☐	
Do you have water flow meter installed?		Yes ☐ No ☐	
If yes what is the flowmeter readings?			
Average number of pumps in village			
Average size of Individual Pumps			

6. OWNERSHIP AND MANAGEMENT

Who owns the system?
Land Owner ☐ Immediate Family ☐ Manufacturer ☐ Installer Company/Service provider ☐
Who operates and Maintenance of the system?
Land Owner ☐ Manufacturer ☐ Installer Company/Service provider ☐ Immediate Family ☐

7. FINANCING AND PAYMENT

Who financed the installation of the system
AEPC ☐ IWMI ☐ ICIMOD ☐ Other ☐
What was your contribution
40% of Total cost ☐ Construction of Shallow Tube well and its fittings ☐ Installation Charge to Technician
Payment method for installation cost
Direct payment by the owner ☐ Loan from a financial institution ☐ Government subsidy ☐

8. FREQUENCY AND DURATION OF PUMP USE

How often is the pump used in year?			
Daily ☐	Weekly ☐	Monthly ☐	Based on cropping patterns)
What many cropping season/patterns do you have?			
a. 3 cropping Seasons ☐	b. 4 Cropping seasons ☐	c. 5 Cropping seasons	d. More ☐
SWP Utilized Months		SWP Unutilized Months	
Falgun Chaitra Bhaishak Jestha # 4 Months – Maize Asar Shrawan Bhadau - #3 Months – Rice		Winter Months mostly Asoj, Kartik, Mangsir , Poush Magh # 5months – Mustard	
How many hours a day is the pump used?			
3-4 hours In Winter days ☐	6-7 hours In Summer days ☐	Others	

9. WATER UTILIZATION

What is the primary use of the water?			
Irrigation purposes ☐	Domestic water supply ☐	Livestock watering ☐	Industrial use ☐
How is the water being stored and distributed			

Directly used without storage ☐ Stored in tanks or reservoirs and distributed manually ☐	Stored in tanks or reservoirs and distributed through a gravity-fed system ☐ Stored in tanks or reservoirs and distributed through a pressurized system ☐
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10. ISSUES ENCOUNTERED/ AFTER SALES SERVICE PROVISION

SWP Status	In Operation	Not in Operation	Have to be reinstalled	
Not in Operation since	Last 1 week ☐	Last Month's ☐	Past Six Months ☐	More than 6 months ☐
Do You know the name of the installer Company (IC)?			No ☐	Yes ☐
			Name of IC	
Communication Channel for reporting issues	Contacting a qualified technician from Installer Company ☐ Local Technician Troubleshooted via phone ☐ Informing the demand collector focal person ☐			
Issues or problems encountered	No issues encountered ☐ Minor issues resolved promptly ☐ Some issues, adequately resolved ☐ Significant issues, partially resolved ☐ Issues remained unresolved ☐			
More details on issues if you know	Electrical Faults ☐ Motor or Pump Failure ☐ Clogged Filters ☐ Controller Issues ☐ Solar Panel damage ☐			
Cost of Repair and Maintenance	Not required until now ☐ Less than NPR 1000 ☐ NPR 5000-10000 ☐ More than NPR 10000 ☐			
Are there trained technical manpower available locally? if yes please name of the operator/technician				
<i>Name of Person</i>		<i>Contact Details</i>		
Are there any local existing enterprises to help you to troubleshoot the problems?				
<i>Name of Enterprise</i>		<i>Contact Details</i>		
Which is nearest local market center for you? And how far is it?				

11. USERS' PERCEPTION TOWARDS SWP TECHNOLOGY

Overall satisfaction from SWP			
Fully Satisfied ☐	Partly satisfied ☐	Totally unsatisfied ☐	
If fully satisfied, what are the reasons?	If partly satisfied, what are the reasons?	If totally unsatisfied, what are the reasons?	
g. Trouble free operation of system ☐	f. Difficult to operate ☐	g. The system has failed, it doesn't work at all	
h. Timely Service by technician ☐	g. Often encounter technical problems ☐	h. Very difficult to operate	
i. Economic Benefit ☐	h. Technicians not available on-demand ☐	i. Often Encounter technical problems	
j. Environmental Benefits ☐	i. Dependent on sun ☐	j. Technicians not available on-demand	
k. Health Benefits ☐	j. More added work ☐	k. Dependent on sun	
l. Workload Reduction ☐		l. More added work	
Is SWP helping for enhancing Income Generation Activities? If yes, what are the reasons			
Increase in agricultural production ☐	Increase in livelihood ☐	Increase in livestock's number ☐	Expansion of the business ☐

12. WILLINGNESS AND ABILITY TO PAY FOR SERVICES

Would you be willing to pay for after-sales service for your solar water pump system?		
Yes ☐	No ☐	
If yes, how much would you be willing to pay for after-sales service on yearly basis?		
Less than NPR 1500 ☐	NPR 5000-10000 ☐	More than NPR 10000 ☐
What type of after-sales service or services is suitable for you?		
Annual Maintenance Contract (AMC) Package:	Based on visit package:	Existing package with more frequent visit provision:

a. Regular preventive maintenance visits scheduled annually b. Priority response time for any service requests c. Comprehensive system check-ups and performance evaluations during each visit d. Free replacement of faulty parts within the contract period e. Discounted rates for additional services or repairs outside the contract scope	a. On-demand visits as per customer's request b. Flexible scheduling of visits based on customer's availability and needs c. Standard system check-ups and performance evaluations during each visit d. Discounted rates for parts and labor during the visit e. Additional services or repairs provided at a separate cost	a. Upgrade to the existing package with increased visit frequency b. Additional visits scheduled throughout the year for enhanced system maintenance c. Thorough inspections, cleaning, and calibration during each visit d. Free replacement of faulty parts within the contract period e. Priority response time for any service requests
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Annexe IV: Survey Questionnaire for Potential Enterprises

1. ENTERPRISE INFORMATION

Form ID	1	Date	DD/MM/YY	Interviewer		Location	
Province		District		RM/Mun		Ward	
GPS Coordinate		Latitude		Longitude			
Name of Enterprise				Mobile No:			
Name of the Owner/Partner interviewed						Female ☐	Male ☐
						Age	

2. ENTERPRISE CHARACTERISTICS & EXISTING SERVICES

Type of business			
a. Proprietorship (unregistered)	b. Registered company	c. Unregistered	d. Other
If registered	PAN	VAT	
Date of Registration			
Place of Registration	Districts	Ward	
If not registered, Does the owner/partner intend to register the enterprise ☐ Yes ☐ No			
How long has your enterprise been operating?			
a. >1 year ☐	b. 1-3 years ☐	c. 5 years ☐	d. More than 5 -10 years ☐
Type of Enterprise			
a. Electrical repair shop ☐	b. Bike workshop ☐	c. Local technician ☐	d. General Repair shop ☐

Type of Service				
a. Repair and Maintenance of equipment/appliances	b. Installation of equipment/appliance	c. Technical troubleshooting and diagnostics	d. Upgrades and modifications of equipment/appliance	
Describe broadly the scope of services presently undertaken, specify				
a. Electrical	b. Electronics	c. Plumbing	d. Civil	e. Solar Related

Experiences with in providing services as			
Company appointed dealer:		Company authorized repair center:	
Franchisee:		Other:	
Mode of Service Request			
a. Walk-in customers at the workshop	b. Phone call or hotline for service requests	c. Online service request on the website	d. Mobile application for service booking
Delivery of Services			
a. On-site service at the customer's location	b. Workshop-based service at the enterprise's facility	c. Both on-site and workshop-based service, depending on the nature of the issue	
Mode of Transportation of equipment, materials, or goods			
a. We have our own dedicated transportation fleet.	b. We rely on external services	c. We have limited transportation resources.	
Coverage area of the enterprise			
a. Local coverage (within a specific city or town) - up to 10 km			
b. Regional coverage (covering multiple cities or towns in a specific region) - 10-50 km			

c. District-level coverage (covering an entire district) - 50-100 km		
d. Provincial coverage (covering an entire province or state) - 100-500 km		
Capacity of your enterprise to handle projects or service requests simultaneously		
a. Up to 5 Projects	b. Up to 5-10 Projects	c. More than 10
Do you have specialized equipment or tools for providing your services?		
a. Yes, we have specialized equipment for our services	b. No, we use general-purpose tools for our services	c. We have a mix of specialized and general-purpose tools.
Are you affiliated with any industry associations or professional networks?		
a. Yes, we are member of _____	b. No, we are not affiliated with any associations.	c. We are in the process of exploring affiliations.
Do you offer warranty or guarantee for your services or products?		

3. KNOWLEDGE OF SOLAR WATER PUMPING SYSTEM (SWPS)

Assessment: Basic Questions:				
Are you familiar with solar-powered water systems?		a. Yes	b. No	
Does your enterprise offer services relate to SWPs?		a. Yes	b. No	
How would you describe your understanding of SWP technology?				
a. Limited	b. Moderate	c. Advanced	d. Expert	
Have you received training SWP installation or repair & Maintenance			a. Yes	b. No
Detailed Questions: If the answer to the previous question is "Yes," please answer the following questions				
What are the main components of a SWP that you are familiar with? (Select all that apply)				
a. Solar panels	b. Pumps	c. Controllers/inverters	d. Not familiar with any components	
What are some common issues or challenges that SWP systems face? (Select all that apply)				
a. Insufficient solar power generation	b. Pump malfunction or low water output	c. Inefficient water distribution	d. Lack of maintenance and servicing	e. Not familiar with any issues or challenges
What is the estimated number of potential customers for SWP repair services in your area?				
What challenges or concerns do you anticipate in setting up a local service network for SWP? (Select all)				
a. Lack of technical expertise and knowledge in SWP systems b. Limited availability of qualified technicians or service providers c. Difficulties in accessing spare parts and components for repairs d. Inadequate infrastructure and resources for servicing and maintenance e. High upfront costs for setting up the service network f. Limited awareness and demand for SWP services in the local community g. I do not anticipate any challenges or concerns				
Are there any specific requirements or support you would need to participate in a local service network for SWP? (Select all that apply)				
a. Technical training & Capacity building on SWP systems b. Access to reliable and affordable spare parts and components c. Financial support or incentives to establish and maintain the service network d. Collaboration & partnerships with other service providers or organizations e. Marketing & promotional support to create awareness and generate demand f. Access to a network or platform for sharing knowledge and best practices				
Do you foresee any challenges in pricing SWP repair services for the local market?				
a. Yes, pricing may be too high for the local market ☐	b. Yes, pricing may be too low to cover costs ☐		c. No, we believe our pricing will be competitive ☐	

4. INFRASTRUCTURE AND RESOURCES

Do you have the necessary infrastructure and tools to handle SWP repairs?	
a. Yes, we have the required infrastructure & tools	b. No, we would need to invest in tools. ☐
Do you have technicians or staff members with knowledge or experience in SWP	

a. Yes, we have technicians with solar system skills	b. No, we would need to train our technicians/staff.
Are you able to allocate dedicated staff members or technicians for SWP repairs?	
a. Yes, we can allocate dedicated staff members	b. No, we would need to manage existing resources
If yes, how many technicians or staff members are available to work on repairs?	
a. 1-2 ☐	b. 3-5 ☐
c. 6-10 ☐	d. More than 10 ☐

5. FUTURE GROWTH & EXPANSION

Would you be interested in expanding your enterprise to offer other renewable energy-related services apart from SWP repairs? YES ☐ NO ☐

6. COLLABORATION & PARTNERSHIP

Would you be interested in collaborating with solar equipment suppliers or other stakeholders to establish a local service network for SWP? YES ☐ NO ☐				
If yes, what specific types of collaboration or partnership opportunities are you interested in exploring? Select all				
a. Supplier Partnerships	b. Financing Partnerships	c. Training and Certification Programs	d. Government and NGO Partnerships	e. Farmer Cooperative Alliances

7. ASSESSMENT BY INTERVIEWER

Does the enterprise's scope of services position it well in principle to provide repair and maintenance SWP?	
If yes, what are the key deficits that would need to be addressed for SWP service and a partnership with POSTED?	
If not, why not?	
Overwhelmingly, what is the owner/partner's perspective?	
Entrepreneurial appetite prevails	
Doubts and concerns prevail	

Annexe V: Site Photos



Figure 33: Interaction with SWP Users