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Application of a Water Pump Semi-Automation Controller to the Irrigation System for Rainfed Rice Fields in Wonorejo Village, Sragen

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Abstract

Rice fields in Wonorejo Village are rainfed rice fields where farmers rely on rainwater to grow crops. To solve this problem, some farmers drill well on their farms, and use submersible water pumps to lift up water to distributed to the rice fields. Prior to this community service activity, the operation of the submersible pump was manually controlled. This operation method had a drawback where excessive irrigation often occurred that could result on damage agricultural commodities, energy waste, and inefficient working time. This community service offers a solution by providing semi-automatic switching devices that will help to overcome this problem. The installed devices replace simple manual switching tools, in which some are in already less safety condition. The device is equipped with a timer that can be used to control the pump automatically as desired, an overload protection component, and equipped with indicator lights that indicate three conditions: the pump is on, the pump is off, and the occurrence of disturbances in pump operation. Evaluation on this community service activities evaluation shows all partners involved in this activity, appreciate this activity, and wanted to be continued in the future.

Keywords: irrigation; rice field; water pump; semi-automatic.

INTRODUCTION

Wonorejo Village, Kalijambe District, Sragen Regency is one of the villages located about 36 km southwest of the capital of Sragen Regency. This village is bordered by Geneng Village to the north, Pakel Village to the west, Donoyudan Village to the south, and Saren Village to the east. It is located at an altitude of about 123 meters above sea level and has an undulating topology with varying degrees of slope. The western part of the village has a surface contour that goes up and down. The eastern part of the village is a lowland with a flatter surface contour. This is where the people's rice fields stretch wide. Most of the people in Wonorejo Village have a livelihood as farmers with the main commodity being food crops/rice. Others have livelihoods as traders, entrepreneurs, civil servants, factory workers, and others.

The rice fields in Wonorejo Village are rainfed rice fields which are located very far from irrigation canal facilities (Figure 1). In the rainfed farming system, farmers only rely on rainwater for farming (Jaramillo et al., 2020). This causes farmers to choose the right plants according to the possibility of water availability (Pirngadi & Makarim, 2014). Farmers can only plant rice at certain times. Farmers will start planting rice in the first planting season, namely at the beginning of the rainy season. After the harvest, they will continue to plant rice in the second planting season. The second growing season usually begins in the rainy season and ends at the beginning of the drought season. The uncertainty of rainfall at the beginning of the drought season is what always haunts farmers in farming. Farmers often experience crop failure because their agricultural land has dried up due to the very short rainfall.

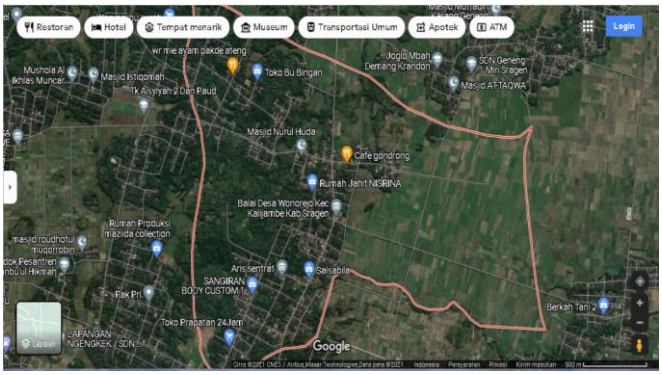

Figure 1. Rice field area of the Wonorejo Village

To overcome this irrigation problem, some farmers have made drilled wells on their agricultural land. At the beginning, farmers used diesel water pumps to irrigate their fields. The fuel costs for this water pump considered as an expensive cost in compare with the agricultural output. To reduce this cost, farmers jointly submitted a request to PLN (State electricity company) to install an electricity network in the rice fields. The reason is because electric water pumps operation cost less than diesel water pump (Arifin et al., 2020). This application was granted by PLN and that farmers could replace diesel water pumps with electric water pumps.

Since the last few years, most farmers have switched to using submersible water pumps supplied by PLN electricity as a substitute for water pumps with gasoline or diesel engines. The existence of water pumps in some rice fields has changed the way farmers cultivate crops. Farmers' planting season has increased to 3 times, 2 times to plant rice and 1 time to plant secondary crops such as peanuts and corn. In operating the water pump, farmers will come to the fields and turn on the water pump switch manually. Usually, farmers will leave the water pump on for irrigating their fields while doing other activities. Farmer will return to the fields when he thinks sufficient and turn off the pump. Sometimes farmers find that their land was not sufficiently irrigated and sometimes farmers find that their land was excessively irrigated. This excessive irrigation results in a waste of inefficient costs. Moreover, excessive irrigation can also have a negative impact on certain agriculture commodities. If they find that their land was not sufficiently watered, farmers will either wait until it finished or they will be left to go home. This manual operation of the water pump is not economical and less efficient in time.

This community service offers a solution by installing water pumps switching mechanism, that is safe, easy to use, and increases the efficiency of time and cost spent by farmers. We applied electronic technology that facilitated the operation of water pumps semi-automatic. Application (Widiyandari et al., 2022)on an appropriate technology in electricity switching will solve the problem (Rohmah et al., 2021).

The solutions we offered are practical, efficient and relatively inexpensive. The use of technology in the electrical field has been widely applied in several countries such as in smart farming schemes (Muangprathub et al., 2019), (Donzia et al., 2019). Some of the applications of this technology in agriculture include irrigation (Keswani et al., 2019), analysis of weather data for agricultural purposes (George & Drăgulinescu, 2019), 2019), as well as monitoring of agricultural land areas (M.Gogoi, 2015). Other application is in combating pest in agriculture (Widiyandari et al., 2023).

METHOD

The implementation of this community service activity carried out in 3 steps of activity and as shown in Figure 2. The first step was socialization and preparation. At this step, a team will visit partners (farmers) to socialize the implementation of community service activities. Discussions were held between the team and partners covering several technical matters including time schedule, personnel involved, and facilities and infrastructure required. Team also mapped the rice fields, the location of wells, and made plans for equipment placement.

The second step was the device preparation, device installation, and partner training. Device preparation was carried out in the electrical engineering laboratory University of Muhammadiyah Surakarta by the academic team. Meanwhile, the installation process in the field was carried out by team and involves partners (farmers). After installation finished, training on the use and maintenance was carried out to trained partners.

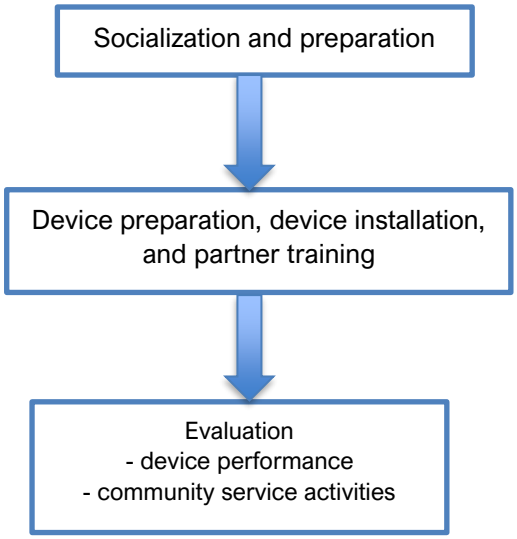

Figure 2. Flowchart of community service activities

The third step was the evaluation. The first evaluation was carried out to see how the devices works and whether partners can operate the devices smoothly. Whenever it found that the devices did not work smoothly, it was then immediately handled by the team. An evaluation was also carried out to assess the benefits of activities for partners and to get feedback on activities from agriculture perspective using questioner form.

RESULT AND DISCUSSION

Socialization and preparation

The first step activities were carried out directly in the field. The team and partners review the field condition and discuss what action needed to solve partner problems according to conditions in the field. Figure 3 and Figure 4 shows some of activities in this step. This direct observation in the field yielded some of the following information:

- PLN has provided a source of electricity with a pre-paid kWh meter.
- The operation of the water pump is done manually directly in the rice field area where wells and pumps are available.
- Operation of the pump is carried out by first filling pre-paid electricity bill, and only then turning on the water pump.
- Due to the time-consuming irrigation process, the partners (farmers) do not wait for the pump while operating, instead of leave it operates until the pre-paid bill runs out and the pump turns off itself. This condition has the potential to cause inefficiency in water and energy resources.
- The pump switching condition is in poor condition, and has the potential to cause a short circuit and electric shock hazard

Figure 3. Field surveys activities

Figure 4. Poor old switching unit condition

Device preparation and installation

This community service involved student teams in carrying out its activities. Students were actively involved both in the device preparation and in device installation in the field. The student team were given an instruction how to prepare the device. After training and briefing, students were entrusted in preparing the devices, starting from determining the workplace station, purchasing components, and preparing the device in accordance to the provided sample device, as seen in Figure 5.

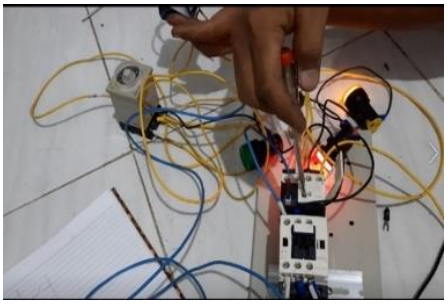

Figure 5. Device preparation in the laboratory

Figure 6 shows the difference between the switch that was previously used by farmers and the new switch that is ready to be installed in the field. The tools installed include contactors, selectors, indicator lights, MCB (Miniature Circuit Breaker), and timer. The existence of a selector will give farmers a choice whether to control manually or automatically. Automatic control is carried out by setting a timer that is easy for farmers to operate. The MCB is used as protection against overload, and the indicator light is used to indicate the pump is off (red), the pump is on (green), and there is interference with pump operation (yellow).

(a) (b)

Figure 6. (a) Old switching unit used by farmers, (b) and the new switching device

Figure 7 shows the event for handing over the device to partners. Before it installed, the student team trained partner how to operate the device (Figure 8). Installation was then conducted by student team member, and the device showed work properly (Figure 9).

Figure 7. The event of handing over the device to partners

Figure 8. Partner training

Figure 9. The installed device works properly

Evaluation

Device performance evaluation was carried out to see how the device works. Evaluation is also conduct to observe that partners can operate the equipment smoothly. The test results showed the device works smoothly in the laboratory as well as in the rice field. Observation result showed that the partner (farmer) operated the device easily.

Evaluation on this community service based on questionnaire result. Questionnaires were given both to partners and to student teams who assisted in the activities. The results of the analysis of partner questionnaires indicate that partner areas are often receiving for community service activities from various university. However, partners stated that never receive community service in applying electronic device to control their electric water pumps. Moreover, partners also stated that the service carried out was very useful, and wanted similar community service, i.e. application of electrical engineering technique to overcome agricultural problems, to be continued in the future. Meanwhile results from student questionnaire showed that this activity was the first community service activity carried out and the students get the benefits of it.

CONCLUSION AND SUGGESTION

The community service has succeeded in applying electrical engineering to overcome agricultural problems related in operating water pumps for irrigating rice fields. The device installed was equipped with a timer that can be used to control the semi pump automatically. The device was also equipped with an indicator light indicating for three conditions, the pump on, the pump is, and some disturbance in pump operation. The device installed showed good performance and can be operated easily by partners. This community activity is considered very useful, both for partners and for the student team involved in the activity. Both parties suggested to continue the community service in the future.

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