
Analysis of the Level of Efficiency, Effectiveness, and Convenience of Using a Pedal Powered Water Pump for Irrigation Activities

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ABSTRACT

Purpose: Analyze the level of efficiency, effectiveness, and convenience of using a pedal-powered water pump for irrigation activities.

Design/methodology/approach: This study uses a qualitative approach by conducting interviews, observations, and documentation on farmers in Carat Village, Pasuruan Regency and conducting descriptive analysis of the data that has been collected.

Findings: The results show that the use of a pedal-powered water pump has various benefits, including efficiency, effectiveness, convenience for farmers, and other benefits.

Research limitation/implications: This research is limited to land that has the same geographical conditions

Practical implications: This research is limited to land that has the same geographical conditions.

Originality/value: This research is original

Paper type: Research paper

Keywords: Convenience, Efficiency, Effectiveness, Irrigation, and Pedal Power

Received : November 11th

Revised : November 11th

Published : November 30th

I. INTRODUCTION

Industrial developments have an impact on the environment and the social environment. The positive impacts include: increasing income, producing various goods, increasing job opportunities, reducing dependence on other countries increasing the use value of raw materials and increasing the country's foreign exchange. While the negative impacts are the occurrence of urbanization, environmental pollution, consumerism, reduced agricultural land, changes in people's way of life, industrial waste that causes soil pollution, and changes in livelihoods. (Ridwan et al., 2007).

This also happens in Carat Village, Pasuruan Regency, which is located between 6 industries. Even though it has 130 hectares of rice fields and 60 hectares of gardens, this village has not been able to improve the welfare of its residents, so it relies on large industries for 32%, agriculture and plantations for 29%, and small industries for 16% (Hatta & Tjahjani, 2019). This is because the conditions are arid with the frequency of irrigation once a week from a moving water reservoir with a capacity of 100 liters in the middle of the land and there is no river water reservoir dam that disrupts plant fertility, reduces crop yields, does not meet market demand, as a result of polluted river water as seen from the changes in color and smells bad even though the ground water is used to watering rice fields and plantations (Umaroh, 2016).



Figure 1. River Conditions and Irrigation Process in Carat Village (Hatta, 2018)

Various forms of irrigation are used today, including irrigation: 1) Surface; 2) Local; 3) Spraying; 4) Traditional with bucket; 5) Water pump; and 6) Dry Land (Susana, 2014), taking into account various things as follows: 1). Irrigation is rarely done in developing countries, 2). The pumps used today are not economically and ergonomically suitable for farmers, 3). Bicycles as one type of general and ergonomic means of transportation, 4). Pedal powered water pump can meet irrigation needs (Gentile et al., 2012). The functions and benefits of the power pedal are shown in Table 1(Weir, 1980):

Table 1. Function and Benefits of The Power Pedal

No.	Function	Benefits How It Works
1.	Winch	<i>The dynapod functions to transport a stationary winch propulsion device for digging, cultivating, harrowing, etc. with cables when soil, weather, and land slope conditions are difficult for humans and animals to cultivate.</i>
2.	Water Pumping	<i>The dynapod is suitable for pumping low lift water and pumping wells with a crankshaft and rod back and forth for high lift.</i>
3.	Fans and Blowers	<i>Pedal-powered fans can be used to dry grain when other energy sources are limited.</i>
4.	Air Compressor	<i>Pedal power can also be used for air compression. Although the power and amount of compressed air is limited, it is sufficient to spray paint or certain plant dusting equipment</i>

Other uses of pedal power: 1). Cassava Graters, 2). Coffee Pulpers, 3). Coffee/ Grain Hullers, 4). Cracking of Oil Palm Nuts, 5). Fibre Decorticaters; Sisal, Manila, Hemp, etc, 6). Threshers, 7). Belers, 8). Potter's Wheels, 9). Flexible Shaft Drive for Portable Grinders, Saber Saws, Band Saws, and Other Equipment that Use Reciprocating Motion, 10). Tire Pumps, 11). Sewing Machines, 12). Electrical Generation; 60-200 watts, e.g.—for film strips or slide projectors. A minimum of 100 watts can be provided by one man for 1/2 hour or more (Weir, 1980).

While the various reasons for using pedal-powered water pumps in several countries, as shown in Table 2 (Gentile et al., 2012)

Table 2. Use of Pedal Powered Water Pumps in Some Countries

Reason	Country	
	India	China
1. <i>People Population in agricultural labor force</i>	58%	50%

2.	<i>Equipment of bicycles</i>	<i>~100M</i>	<i>~750M</i>
3.	<i>Demand Need</i>	<i>for irrigation water predicted to rise dramatically</i>	<i>only 40% of cultivated land is irrigated, yet produces 67% of crops (www.worldbank.org)</i>
4.	<i>Potential Concern</i>	<i>not socially acceptable for women to ride bicycles</i>	<i>Many government sponsored irrigation projects fail due to poor efficiencies and lack of system maintenance</i>

II. METHODOLOGY

This study uses a qualitative approach by conducting interviews, observations, and documentation on farmers in Carat Village, Pasuruan Regency to determine the efficiency, effectiveness and comfort level of using a pedal-powered water pump. Then a descriptive analysis was carried out on the data that had been collected in order to obtain clarity in accordance with the objectives of this study.



Figure 2. Interviews, Observations and Documentation with Farmers (Hatta & Tjahjani, 2019)

III. RESULT AND DISCUSSION

Currently, the water used for irrigation comes from 2 wells the location is quite far from people's homes, taken by renting a diesel engine for Rp. 100,000,-/use or pay for the labor of two workers Rp. 70,000,-/person/week to watering rice fields within ± 100 – 200 meters by drawing water and carrying two gembor weighing ± 20 kg for up to 3 months of harvest (12 weeks). These costs are still added to the purchase of biodiesel and rental pick-up to move the diesel engine (Hatta & Tjahjani, 2019).

This condition is a problem that must be faced by farmers in Carat Village, because:

1. Energy wastage and operational expenses are quite high because they have to rent diesel engines, biodiesel, labor, and picks up which have an impact on the minimum income of farmers every time they harvest.
2. The occurrence of injuries to the spine, muscle tissue and joints due to drawing water, filling reservoirs and irrigating rice fields repeatedly (repetitively) and excessively which is quite tiring with unnatural body postures, resulting in complaints such as soreness, tingling, and pain in the bones (Ginting et al., 2016).
3. Complaints of musculoskeletal disorders due to work done with wrong work postures, heavy loads and non-ergonomic tools (Mahardika & Pujotomo, 2014).

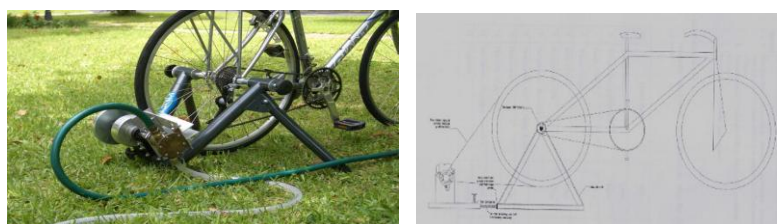


Figure 3. Bicycle Powered Water Pump (Gilg, 2006) and Final Design of a Pedals Powered Water Pump (Hatta, 2014)

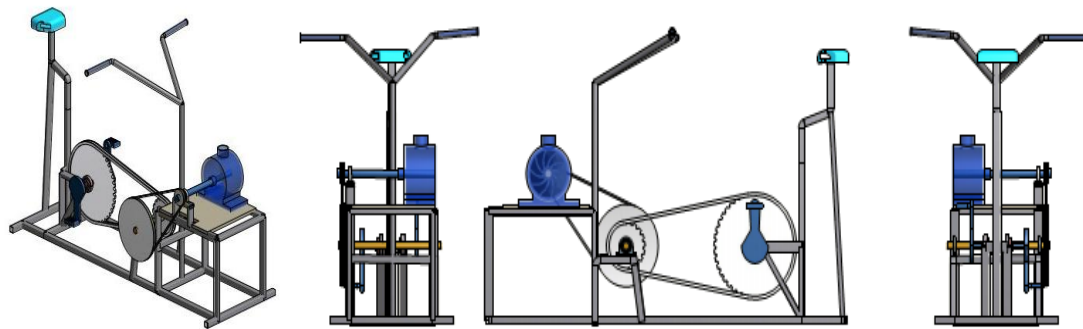


Figure 4. A Pedal Powered Centrifugal Water Pump (PPCWP) (Akinnuli et al., 2019)

Large gear ratio and pedal range when using certain gear combinations (Bebe, 2014), described in Table 3.

Table 3. Gear Comparison and Pedal Range in Certain Gear Combinations

21 SPD	1	2	3	4	5	6	7								
CWCS	30	26	23	20	17	15	13								
Comparison	Ratio	Range	Ratio	Range	Ratio	Range	Ratio	Range	Ratio	Range	Ratio	Range	Ratio	Range	
1	22	0.73	1.50	0.85	1.70	0.96	1.90	1.10	2.20	1.29	2.60	1.47	2.90	1.69	3.40
2	36	1.20	2.40	1.38	2.80	1.57	3.10	1.80	3.60	2.12	4.20	2.40	4.80	2.77	5.50
3	46	1.53	3.10	1.77	3.50	2.00	4.00	2.30	4.60	2.71	5.40	3.07	6.10	3.54	7.10

Therefore, the various benefits of the pedal-powered water pump innovation are described in Table 4 below:

Table 4. Benefits of Pedal Powered Water Pump Innovation

No.	Benefit	Reason
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Operational Cost Savings:

$$\text{Diesel engine rental} = 12 \times \text{Rp. } 100.000,- = \text{Rp. } 1.200.000,-$$

$$\text{Labor wages} = 2 \times 12 \times \text{Rp. } 70.000,- = \text{Rp. } 1.480.000,- +$$

$$\text{The amount of costs} = \text{Rp. } 2.680.000,-$$

Supporting Cost Savings:

1. Efficiency

$$\text{Pick up rental} = 12 \times \text{Rp. } 75.000,- = \text{Rp. } 900.000,-$$

$$\text{Biosolar / liter} = 4 \text{ ltr} \times 12 \times \text{Rp. } 10.000 = \text{Rp. } 480.000,- +$$

$$\text{The amount of costs} = \text{Rp. } 1.380.000,-$$

$$\text{Amount of Savings} = \text{Rp. } 2.680.000 + \text{Rp. } 1.380.000,-$$

$$= \text{Rp. } 4.060.000,-$$

- | | | |
|----|----------------------|--|
| 2. | <i>Effectiveness</i> | <i>It is recommended to choose chaining 22 with 30 sprocket</i> |
| 3. | <i>Convenience</i> | <i>More comfortable and ergonomic</i> |
| | | <i>Low cost, easy to operate, readily available materials, simple design, productive, limited power supply, and can be used anywhere (village or city)</i> |
| 4. | <i>Etc</i> | <i>Save energy, reduce pollution, can maintain physical fitness, and increase solidarity between farmers</i> |

Therefore, the innovation of a pedal-powered water pump that has been carried out to facilitate the irrigation system can provide various benefits which in the end is expected to increase crop yields, productivity, and competitiveness compared to harvests outside Carat Village so that farmers' welfare is achieved.

ACKNOWLEDGMENTS

The authors much acknowledge the support from Universitas 45 Surabaya, East Java, Indonesia for providing the necessary resources to this research. The authors are also grateful to the anonymous reviewers and journal editorial board for their many insightful comments, which have significantly improved this article.

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