MULTIDISCIPLINARY APPLIED RESEARCH AND INNOVATION
e-ISSN: 2773-4773

MARI

Vol. 5 No. 1 (2024) 94-101
https://publisher.uthm.edu.my/periodicals/index.php/mari

Mini-Hydro Project for Street Lighting

Nur Aelya Ruzaini Nazli, Nur Syazwina Samsudin, Muhammad Kamal Hakim Kamaruddin, Nor Baizura Hamid*

Department of Civil Engineering, Centre for Diploma Studies,
Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

**Corresponding author: norbaizura@uthm.edu.my*
DOI: https://doi.org/10.30880/mari.2024.05.01.015

Article Info

Received: 01 September 2023
Accepted: 10 December 2023
Available online: 31 January 2024

Keywords

Hydroelectric, Mini-Hydro, Street Light, Voltage, Power

Abstract

Hydro energy is widely used around the world and can generate electricity using the flow of moving water. Hydroelectric energy can be saved and used to address the problem of the electrical supply if it is stopped. The problem of insufficient electricity supply in rural areas will cause many problems for road users. Furthermore, if the electricity supply is cut off, hydroelectric energy can be stored, allowing the electricity supply problem to be solved. One of the causes of road accidents is a lack of street lighting on the roads, particularly in rural areas. This study discusses the use of hydroelectric energy in supplying electricity, especially to streetlights in rural areas. The objective of this study is to get user feedback on the importance of streetlights while driving. Besides, to design a mini-hydro project that uses water turbines for street lighting as a new source of power, The output voltage, current, and power of the mini-hydro project have also been determined. The method used to achieve the objectives was a survey on Google Forms. Next, the model was tested by using a multimeter to measure the voltage of the power current. The first objective demonstrates that 98.4% of the 128 respondents to the survey concurred that streetlights are essential for safe driving. In view of this, 96.1% of respondents concurred that one of the elements influencing driving safety is the intensity of streetlights. Next, the model was successfully developed based on user suitability because of the research done. This model can generate voltage and power of 5.181 V and 0.988 kΩ, respectively. In conclusion, this study achieved all the objectives of the mini-hydro project's development.

.

1. Introduction

Hydroelectricity is renewable energy that can generate electricity. Renewable energy is energy that is derived from renewable natural resources, such as sunshine, wind, rain, waves, and geothermal energy. Renewable energy is starting to become the main source of global electricity generation by the 21st century [1]. Examples of renewable energy sources include biomass, hydroelectricity, wind, and solar energy [2]. Hydropower will become a major source of energy, contributing up to 27% of Malaysia's electricity generation by 2020 [3]. It is one of the most extensively used renewable electricity sources in the world. When a river is at its lowest point, certain hydroelectric power plants transform the potential energy of the water there into mechanical energy, which is then converted into electrical energy [4]. Electricity is produced by hydropower using the natural flow of moving

water. In this era, the world and other countries realized that raw materials such as coal did not always exist. However, the need for energy is constantly increasing to meet the needs of people around the world [5]. This new and renewable energy refers to a resource that can be used continuously and does not run out [7]. This energy is also a source of energy and an alternative that is known as environmentally friendly because it does not produce waste that can damage the environment [2].

Energy which is renewable in contrast to fossil fuels or petroleum, which produces carbon dioxide gas and various other harmful substances [6]. The natural energy of moving water is harvested by guiding the water through a turbine, which converts the energy of the moving water into mechanical energy. In a generator, mechanical energy is converted into electricity [8]. This alternative source can overcome the problem of the energy generation crisis while also guaranteeing the stability of the country's economy [9]. In addition, new renewable energy can be obtained for free. Low operating expenses due to maintenance are cheap, and the energy source is free [2]. With such conditions, renewable energy sources can help the country in the future with its energy crisis [9]. A water turbine can be defined as a mechanical device in the form of a wheel, with the blade around the sharp edge placed on a horizontal axis. Water turbine is a medium of water that works to rotate to produce electricity [10].

This study discusses the benefits and applications of hydroelectric energy for supplying power, particularly for street lighting in rural areas. Additionally, hydroelectric energy can be stored and used to solve the electricity supply issue if the supply is interrupted. In nations with swift river currents, this energy can be used. For instance, Malaysia has good water quality and flow, which can be used to generate power. Furthermore, compared to other energy sources like solar energy, wind energy, and biomass from palm oil, employing this hydroelectric energy source only has a small cost. In this study, hydroelectric energy has been employed as a source of electricity to power streetlights in rural areas. In this study, water turbines are also used to produce electricity, which is then used to power street lighting. This is because a new source of energy, kinetic energy from water turbines, can produce electricity for use in streetlights.

The objective of this study is to get user feedback about the importance of streetlights in driving, which can be obtained based on a questionnaire that will be distributed to road users. Next, design a mini-hydro project that uses water turbines as a new source of power and is used in streetlights. This mini-hydro project is expected to produce a working model that uses water turbine power as a new power source and can be used for streetlights. This project is expected to raise awareness in the community and the environment about the benefits of water energy as a new power source capable of channeling electricity. The next objective is to determine the output voltage, output current, and power of the mini-hydro project. The effectiveness of this model can be determined by testing the output voltage, output current, and power of the water turbine product that flows electric power to streetlights.

2. Materials and Methods

The research was carried out according to the flow chart in Fig. 1. The procedures followed during this study are indicated in the diagram.

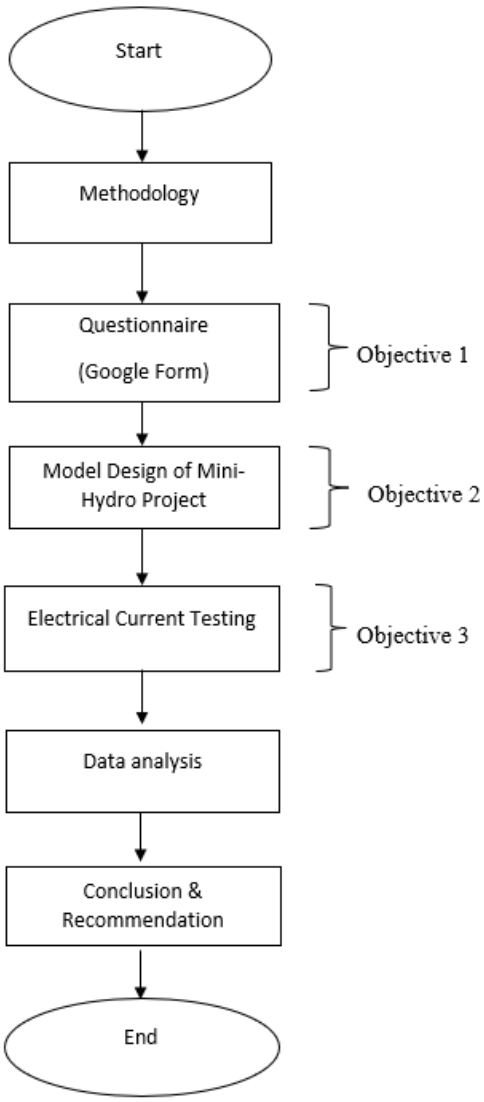


Fig. 1 *Flowchart of the study*

2.1 Materials

Generators, wheels, turbines, DC motors, LED lights, and power bank kits were utilised in this study to design a mini-hydro project that uses a water turbine as a new power source and is employed in streetlights. A generator, sometimes known as an electric generator, is a device that converts mechanical energy into electrical energy, as shown in Fig. 2(a) and Fig. 2(b) depicts a water wheel used in a water turbine model that, as it revolves, converts the energy of flowing water into various useful kinds of power, such as electricity.

A water turbine, as shown in Fig. 2(c), is a rotating mechanism that converts kinetic energy from a flowing water current into electrical energy. A DC motor, such as the one shown in Fig. 2(d), is also a crucial component in the design of a mini-hydro project. A direct current motor (DC motor) is a revolving device that transfers direct electrical energy to mechanical energy. Following that, LED lights are electric lights that can be employed in light fixtures, as illustrated in Fig. 2(e). Finally, the major component is the power bank kit, as seen in Fig. 2(f). Power bank kits are designed to create power using natural resources such as water, sunshine, or wind.

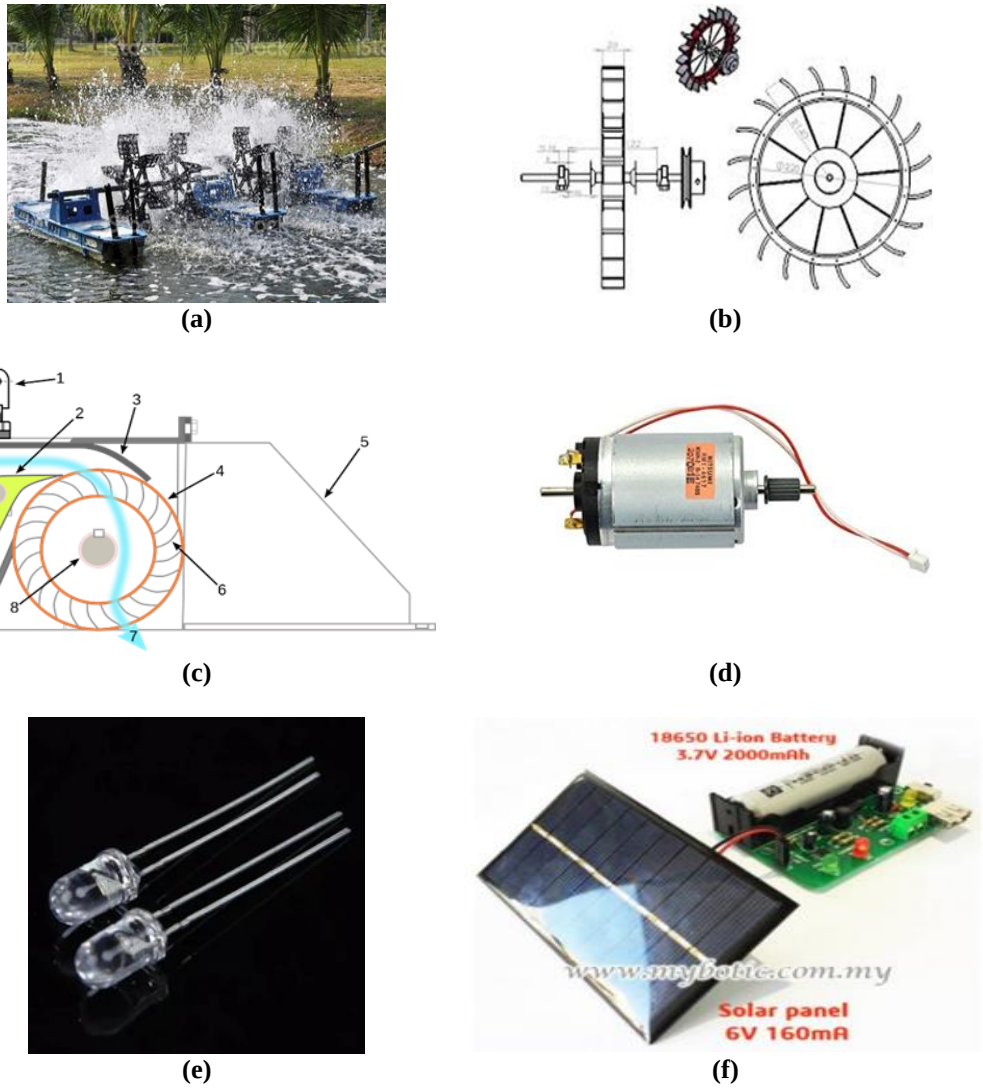


Fig. 2 *Material. (a) Water Turbine Generator, (b) A wheel used for a water turbine, (c) Turbine, (d) DC Motor (e) LED light, (f) Power bank kit*

2.2 Methods

2.2.1 Questionnaire

The first objective can then be obtained through a questionnaire. A questionnaire is a type of research instrument that is frequently used by researchers to collect data. A questionnaire will be developed based on the study's goal, which is to determine safety aspects including driving behaviour, in relation to the sensitivity of streetlights at a specific site. The questionnaire will be given at random to 128 respondents through Google Forms. This questionnaire is divided into two sections: Part A, which contains demographic information about the respondent, and Part B, which has questions on identifying safety aspects involving driving behaviour and the level of sensitivity of streetlights in a specific place.

Based on the research data, a questionnaire was distributed to University Tun Hussein Onn Malaysia students and some residents in the Panchor Pagoh area. This is because there is a route from University Tun Hussein Onn Malaysia towards Bukit Gambir that has less efficient use of streetlights compared to other surrounding areas. The Panchor area and its surrounds are the focus of this research because of the presence of a running river.

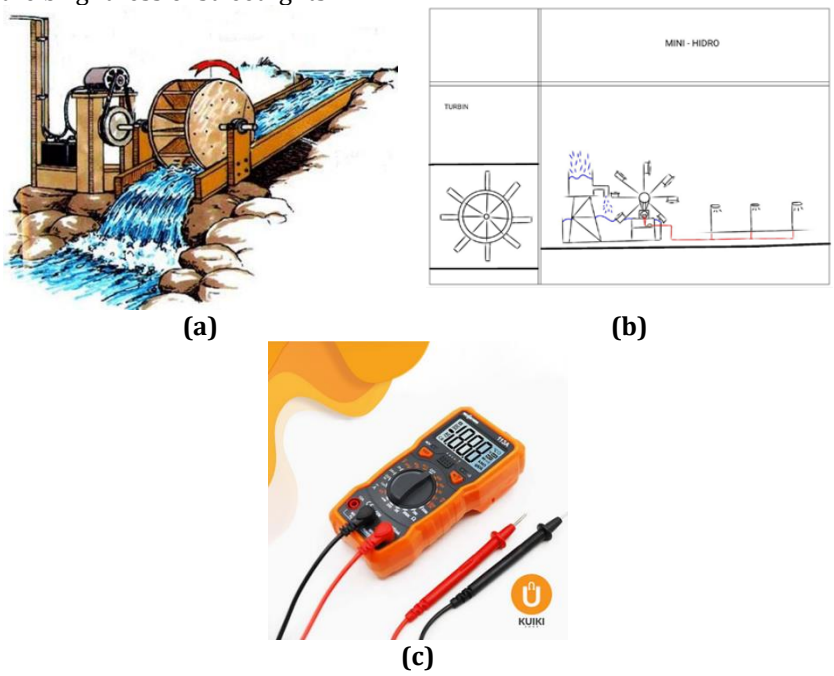
2.2.2 Model Design of Mini-Hydro Project

The Mini-Hydro concept is based on a watermill that uses rain catchment water and rivers to transport electric current to street lights. Mini-hydro models will be constructed from recycled materials such as bottles and paper boards. A crossflow turbine, as shown in Fig. 3(a), is used to control the angle of the direction of the water flow and convert it into an electrical source.

Fig. 3(b) depicts the outcome of the mini-hydro project building sketch that was created. This mini hydro was built with the AutoCAD 2022 programme. The building of this mini hydro is developed in two dimensions (2D), starting with the project's front perspective.

2.2.3 Electrical Current Testing

Voltage testing can be used for mini-hydro project testing. This test is performed to determine the electrical resistance of the mini hydro that can be accommodated as well as the percentage of power (watts) that can be used to power the streetlights. A multimeter, as shown in Fig. 3(c), was used to determine the voltage and current that could be produced by the turbine. Changes in water flow have an impact on the power flow (watts) of street lighting. When the flow of river water is rapid, the reading on the multimeter rises. As a result, the power output will increase, as will the brightness of streetlights.



(a) **(b)**

(c)

Fig. 3 *Model design (a) Crossflow Turbine, (b) The Mini-Hydro model uses AutoCAD software, (c) Multimeter.*

3. Results And Discussion

Our group has done a survey on the use of hydro energy in streetlights and has created a Google Form that has been distributed by residents in their area. The results of the data taken have been taken and plotted in the form of a table and in the form of a pie chart.

3.1 Questionnaire

The Pagoh area is a city that is growing from time to time, making this area will increase the number of growth rates. As is known, more residential areas have been built as well as more nearby university students and surrounding residents will pass through the area along the route towards the Bukit Gambir. The data from this questionnaire is the opinion of University Tun Hussein Onn Malaysia students and residents in the Panchor area. Data gathered from Google Forms reveals that 128 individuals responded to the survey for Part A. A total of 46.1% of respondents were teens, with an average age of roughly 18 to 20 years. While 62.5% of respondents were female, most respondents who provided input indicated that the population growth rate in their region is rising, with 91.4% of respondents agreeing, as shown in Table 1.

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) 94-101

Table 1 *Result of the number of respondents*

Questions	Findings	
	Frequency	Percentage (%)
Age	59	46.1
18-20	29	22.7
21-23	24	18.8
24-39	16	12.5
40 and above		
Gender		
Men	48	37.5
Women	80	62.5
The growth rate in your area		
Increase	117	91.4
Decrease	11	8.6

For Part B, the questions are about the experience and knowledge of the respondents about road safety. A total of 80.5% of those who responded indicated that they had previous driving experience. 98.4% of respondents believed that streetlights were important when driving. In addition, up to 57% of respondents claimed that road accidents often occur in urban areas. Finally, 94.5% of respondents agreed that streetlights have a role in accident prevention.

Due to the questions presented, it can be seen what the opinions of the respondents are regarding the importance of streetlights for drivers. For example, streetlights are important for drivers, especially those with vision problems such as nearsightedness or glare. Accident rates will increase in the absence of streetlights because drivers will not have access to lights to complete their journeys and because the increase in road accidents is associated with the increased intensity of streetlights. Finally, as a summary, most of the respondents agreed that streetlights are very important for road users. This can be linked to the increase in road accidents in Malaysia. Not only that, but it can also be seen from the results of the respondents in Fig. 4, which is 96.1%, who said road accidents often occur in urban areas. It can be accepted that the rapid increase in population in urban areas, such as tourists and the arrival of foreigners in urban areas, causes road accidents to often occur in cities. Therefore, the construction of streetlights is very important for the convenience and safety of road users.

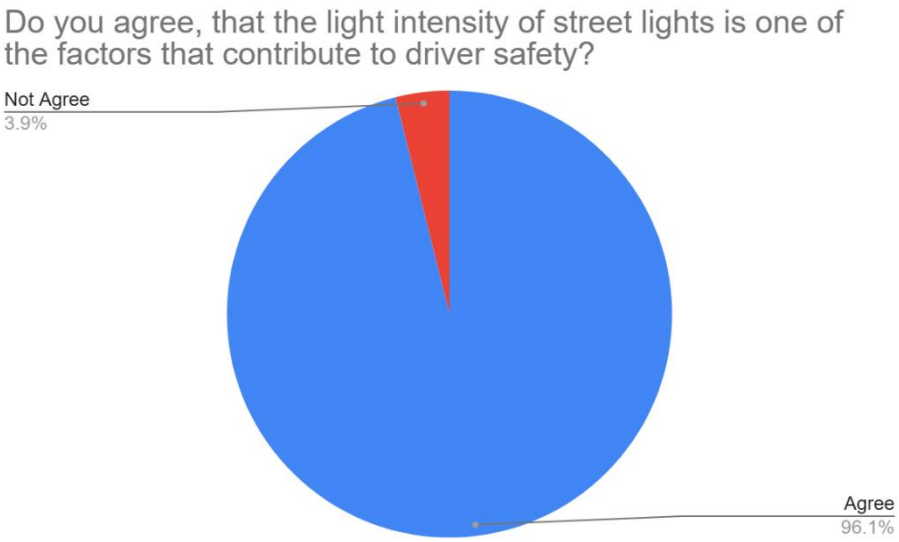


Fig. 4 *Respondents' experience and understanding of road safety.*

3.2 Model Design of Mini-Hydro Project

The model design of the mini-hydro project has been successfully completed, encompassing all the essential components and considerations as shown in Fig. 5. The design includes the following key elements:

- Water Intake, a well-designed water intake structure has been incorporated to efficiently capture water from a river or stream. It ensures a sufficient and consistent water supply for the power generation system.
- Turbine, the turbine's selection, and design were finalized based on the project's specific requirements and site conditions. The crossflow turbine was chosen for this project.
- Generator, the design includes a suitably sized and specified generator. It transfers mechanical energy from the turbine into electrical energy effectively, ensuring maximum power output.
- Powerhouse, the powerhouse's design is complete, and it now provides a safe and regulated environment for the turbine and generator. It includes safety precautions, ventilation systems, and maintenance access to guarantee that the power-producing equipment operates efficiently and safely.

Fig. 5 *Model Design of Mini-Hydro Project*

The model design of the mini-hydro project was successfully completed through rigorous engineering studies, environmental evaluations, and expert consultation, encompassing all relevant components and factors. It provides a sustainable and optimized framework for efficient power generation while minimizing environmental concerns.

3.3 Electrical Current Testing

As shown in Table 2, the data obtained was taken and tested using a multimeter. All the readings were taken three times, and the average data was recorded. The applied voltage was 5.181 V. However, the current cannot be identified using a multimeter because it has a minimal value. Besides, the power applied to the streetlights model is 0.988 kΩ.

Table 2 *Electrical Current Testing*

Parameter	Reading
Voltage (V)	5.181
Current (μA)	NIL
Power(kΩ)	0.988

The reading obtained is small because this model is on a small scale, so for actual use, it is necessary to use the appropriate voltage. Therefore, the data obtained shows the lamp's brightness on the Mini-Hydro power model can function well. This model can be applied in dark areas, such as villages, to reduce the occurrence of accidents caused by dark spots. This model can also show the advantages of using renewable energy in society.

Conclusion

In general, it can be said that all the objectives were satisfactorily accomplished. The first objective shows that 98.4% of the 128 respondents who responded to the survey conducted using Google Forms agreed that streetlights are crucial for safe driving. Therefore, 96.1% of respondents agreed that the light intensity of streetlights is one of the factors that contribute to driver safety. The second objective is a model developed to produce renewable energy and used as a power source for streetlights. The next objective is evident from the fact that a multimeter test of an electric current was conducted to determine the maximum strength of the current that could be passed through the small hydro model. The created model successfully generated 5.181 V of voltage and 0.988 kΩ of power. The test can be used to determine values for current, voltage, and power. The findings demonstrate that the mini-hydro model's power current from the collected data is enough. In conclusion, this project was successful according to the objectives given.

Acknowledgment

This research was funded by Tier 1 Grant Vot Q396 provided by the Universiti Tun Hussein Onn Malaysia (UTHM). The authors would like to thank the Centre for Diploma Studies (CeDS), Universiti Tun Hussein Onn Malaysia for their support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design, data collection, draft manuscript, draft manuscript preparation:*** *Nur Aelya Ruzaini Nazli, Nur Syazwina Samsudin, Muhammad Kamal Hakim Kamaruddin, Nor Baizura Hamid. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] Aslam, M., & Zulkifli, D. (2013) Renewable energy in Malaysia: experience from Perlis, *J Energy Technol Policy, 3(11),* 1-5.

[2] Hamid, H. H. B. A., Zakaria, I. B., & Othman, M. S. B. (2019) Tenaga Boleh Diperbaharui Bagi Penjanaan Tenaga Elektrik di Malaysia: Satu Kajian Literatur, *Journal on Technical and Vocational Education, 4(3),* 129-142.

[3] Ahmad, A., & Wahab, M. A. (2000) [Hydro-electric power and environmental management in Malaysia during 2020, *In RECEE 2000 Regional Conference on Energy and Environment proceedings: the Emerging Energy Technologies,* Universiti Tenaga Nasional.

[4] Khan, M. J., Iqbal, M. T., & Quaicoe, J. E. (2008), River current energy conversion systems: Progress, prospects and challenges, *Renewable and sustainable energy reviews, 12(8),* 2177-2193.

[5] Jasmi, K. A., & Mat Udin, S. (2013) Bootani, zoologi dan tenaga dari perspektif Al-Quran. *Skudai: Universti Teknologi Malaysia,* 33-47.

[6] Abdullah, W. S. W., Osman, M., Ab Kadir, M. Z. A., & Verayiah, R. (2019), The potential and status of renewable energy development in Malaysia, *Energies, 12(12),* 2437.

[7] Hashim, H., & Ho, W. S. (2011), Renewable energy policies and initiatives for a sustainable energy future in Malaysia, *Renewable and Sustainable Energy Reviews, 15(9),* 4780-4787.

[8] Andrews, J., Jelley, N. A., & Jelley, N. (2022) Energy science: principles, technologies, and impacts. *Oxford university press.*

[9] Hapsari, O. E. (2018) Analisis Penerapan Green Building Pada Bangunan Pendidikan (Studi Kasus: Green School Bali), *Al-Ard: Jurnal Teknik Lingkungan, 3(2),* 54-61.

[10] Morong, J. Y. (2016) Rancang Bangun Kincir Air Irigasi Sebagai Pembangkit Listrik di Desa Talawaan *(Doctoral dissertation, Politeknik Negeri Manado).*