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Application of PV systems in the process of drying fish for traditional fisherman

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ABSTRACT

The catch of fish is so large and often not completely sold, causing the fish to be wasted for free. This situation even indirectly causes environmental pollution around the area where fishermen live. To overcome this problem, a fish drying machine was made using a PV system. This tool is also a form of solving the problem of the traditional fish drying process which is sometimes not clean, safe, and depends on direct sunlight. This PV system can meet 169.95% of the need for 240 Wh/day of electrical energy from fish dryers. PV system can produce electrical energy for 407.81 Wh/day, where the largest energy can reach 520 Wh and the smallest is 160.8 Wh. The results of the analysis of the impact of using fish dryers socially and economically also gave significant results ($p<0.005$), where there was an increase from before and after the use of fish dryers experienced by fishermen. When viewed from the perspective of fishermen on the tool, the accuracy of the use of the tool, the benefit factor, and the shape of the fish dryer, the fishermen gave a good response, with an average value of 4.19-5.26.

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1. INTRODUCTION

Fish is one source of animal protein that is widely consumed by the public, because it is easy to obtain and the price is relatively cheap [1]–[4]. However, fishery products are commodities that are prone to deterioration and spoilage. This causes the need for a fast, precise and correct handling process to maintain quality before being marketed and reaching the hands of consumers. Therefore, it is necessary to have a preservation process to extend the shelf life of fish [1], [4]–[7].

Processing and preservation is an attempt to improve the quality of storage and durability of post-harvest fishery products [8]–[10]. The purpose of this activity in principle is to overcome excess production and at the same time maintain the quaity of fish before it is marketed or consumed, increase the marketability of fish, as a food diversification material and to extend the shelf life. Fish processing and preservation is an important part of the fishery industry chain [5], [8], [11]. Without these two processes, the increase in fish production that has been achieved so far will be in vain, because not all fishery production can be utilized by consumers in good condition. Preservation of fish traditionally aims to reduce the water content in the fish's body, so as not to provide an opportunity for bacteria to breed. To obtain good and high-quality preservation results, good treatment is needed during the preservation process, such as maintaining the cleanliness of the materials and tools used and using fresh fish. There are several kinds of fish preservation processes, namely salting, drying, pemindangan, impregnation, fermentation and cooling of fish [12]–[17].

The fishermen in Indonesia carry out the traditional fish drying process by using direct sunlight. Drying using this method is usually done by placing the fish products on a fishing net, mat, floor mat or woven bamboo and placed in the sun. This method is unhygienic and allows the dried product to lose some of its weight, as it is eaten by insects, birds, cats or other animals. In addition, the product will be easily exposed to dust. The drying process will be delayed if it rains, so the expected results are not optimal and the amount of production produced is not appropriate [18]–[21]. These conditions led to an idea to design and manufacture a hybrid fish dryer by utilizing energy from the sun with the type of greenhouse effect. Fish drying machine is made using solar energy which is then used to help the fish drying process [22]. The potential of solar energy that is so good in Indonesia is one of the reasons for using this energy [23], [24]. The tool made will also be able to be integrated with IoT so that it can make it easier to know the condition of drying fish [25]–[27].

This research aims to make a tool and determine the capacity of the tool in carrying out the fish drying process as well as a form of the blue economy in accordance with the policies of the Ministry of Marine Affairs and Fisheries Republic of Indonesia [28]–[31]. This system will also be an introduction to fishermen who still do a little bit of fish scraping in several areas in Indonesia. The potential for such large fish is very suitable to be developed considering that this activity can improve the economy of the fishermen, and indirectly support tourism in the region [29], [32], [33]. Based on the confession of fishermen who were interviewed in the areas of Bali and East Nusa Tenggara, there are still few who do fish drying. The huge potential of fishery products can be developed if it is seen that the activities are only selling fresh fish and fish that are not sold are usually just thrown away and not processed anymore. The existence of a fish dryer can help to process excess fish products by utilizing solar power technology and the ease of monitoring the drying process through the IoT system [26], [34], [35]. This fish dryer is also not dependent on the weather so that the drying process does not require a long time and the hygienic quality of the fish can be maintained.

2. METHOD

This research was conducted on a group of fishermen in East Seraya, Karangasem, Bali. This location was chosen because it is one of the tourist attractions in the sea and fish market. There is a group of fishermen's associations, Vishnu Fortune. This fishing group has 27 members with the chairman I Wayan Candra. As a result of the Covid-19 pandemic that has occurred since 2020 in Indonesia, a lot of excess fresh fish catches have to be wasted and eventually rot. This eventually causes environmental pollution around the area. Therefore, a fish dryer was made using a hybrid system using electrical energy sourced from the sun and energy from the sun directly.

The study was conducted for 31 days, from April 14 to May 14 2022. The data taken in this research were environmental conditions, questionnaires from respondents, data on the electrical load of fish dryers and electrical energy that can be generated by solar panels every day. This environmental condition data includes air temperature, wind speed, and environmental humidity in the East Seraya area. The results of the questionnaire were obtained from 27 fishermen who are members of the Wisnu Fortune Fisherman Group using a 6-answer Likert measurement scale. This was chosen in order to provide a variety of answers by respondents. The questionnaire data obtained were then analyzed using a paired T-comparative test and frequency distribution to determine the respondents' responses to the tools made. Prior to testing, the questionnaire data was tested for validity and reliability. The results of the questionnaire data in this study obtained valid results, and for the reliability results with the Cronbach's Alpha test, the results were 0.688.

The fish dryer is made using a system that dries fish using UV light when there is no sunlight and can be monitored using smartphones and websites. Solar panels are used to generate electrical energy and then this energy is channeled to the battery via the charge controller. This study aims to obtain optimal results in the fish drying process and as a comparison the drying process with sunlight without being compared to using UV lamps protected with UV plastic. In this study, only the electrical system is discussed, namely the need for a PV system used in fish drying equipment. The design of the fish dryer can be seen in Figure 1.

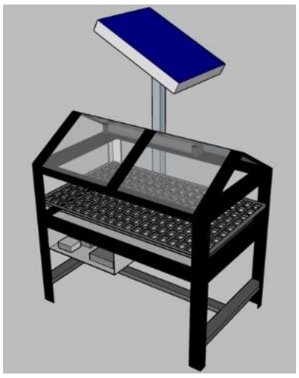

Figure 1. Fish drying machine design

3. RESULTS AND DISCUSSION

3.1. Fish dryer technical test

This fish dryer uses an electrical energy source from a 100 WP solar panel and a 12 V 65 Ah storage battery, which is then lowered to 4.9 VDC using a buck converter. This PV system can meet 169.95% of the need for 240 Wh/day of electrical energy from the dryer. The electrical load of this system comes from a 10W UV lamp and a 5W control system. The electrical system of the fish drying device can be seen in Figure 2.

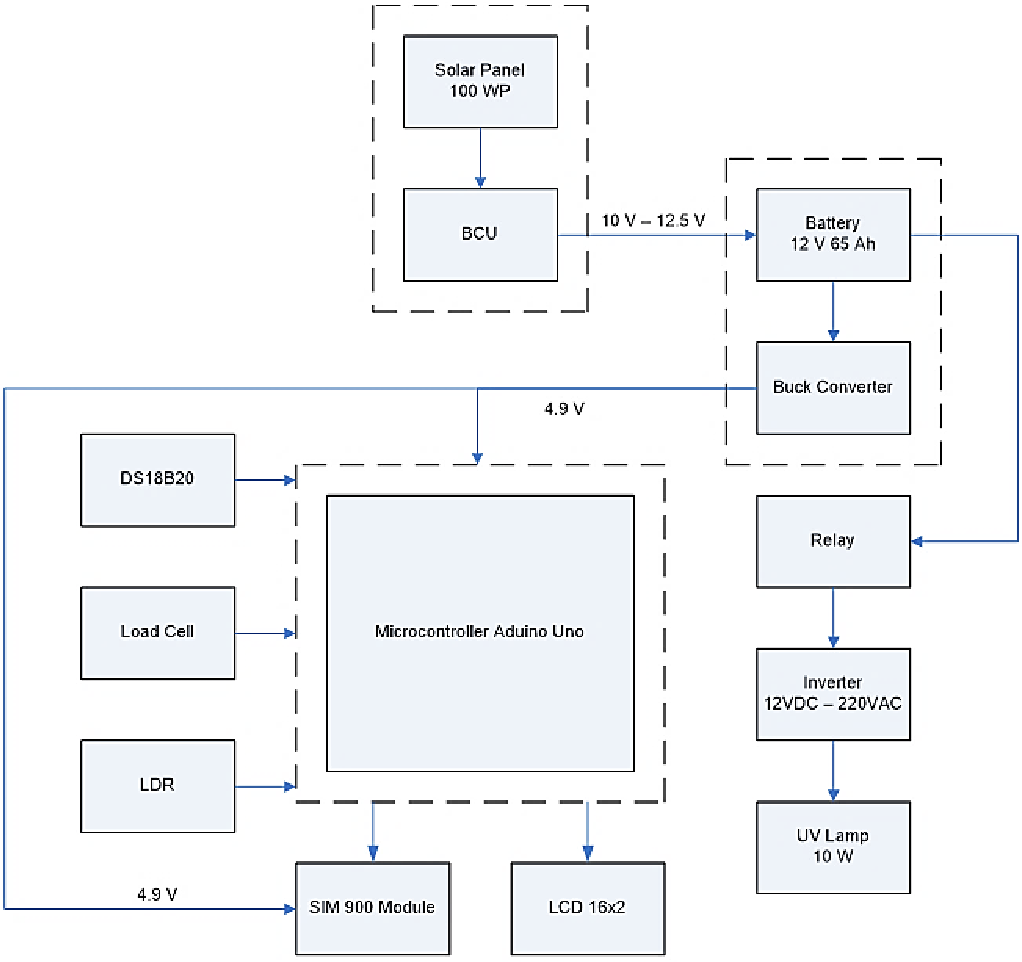

Figure 2. The electrical system of the fish drying device

During the utilization of fish dryers in Seraya Village, PV can produce electrical energy of 407.81 Wh/day, where the largest energy can reach 520 Wh and the smallest is 160.8 Wh. The difference in output energy produced is caused by several environmental factors, including air temperature, wind speed, and air humidity around the installation location of the fish dryer [24], [36], [37]. The environmental conditions for 31 days can be seen in Table 1, while the energy output from PV installed on the fish dryer can be seen in Figure 3.

Table 1. The environmental conditions at Seraya Village

Day	Temperature (ºC)	Wind Speed (m/s)	Humidity (%)
1	27.71	2.62	79.25
2	27.84	2.17	81.12
3	27.64	1.71	81.06
4	27.57	1.37	80.5
5	27.45	1.4	82.75
6	27.01	2.53	85.12
7	26.23	1.19	80.94
8	27.08	1.82	80.44
9	27.37	2.02	81.62
10	27.24	2.56	85.19
11	27.41	3.03	84.56
12	27.8	3.48	78.69
13	28	1.53	72.75
14	28.12	1.84	72.25
15	28.24	1.55	73.88
16	27.7	2.7	83.5
17	27.79	2.8	81.81
18	27.83	2.23	79.5
19	27.9	3.12	82.31
20	27.64	3.49	83.75
21	27.3	3.74	85
22	27.33	3.62	84.44
23	27.23	3.46	85.19
24	27.99	2.8	83.19
25	28.11	2.13	83.38
26	27.83	2.68	85.75
27	27.57	3.8	82.69
28	27.51	2.48	81
29	27.8	1.69	82.56
30	27.42	2.3	85.94
31	27.77	1.77	79.31

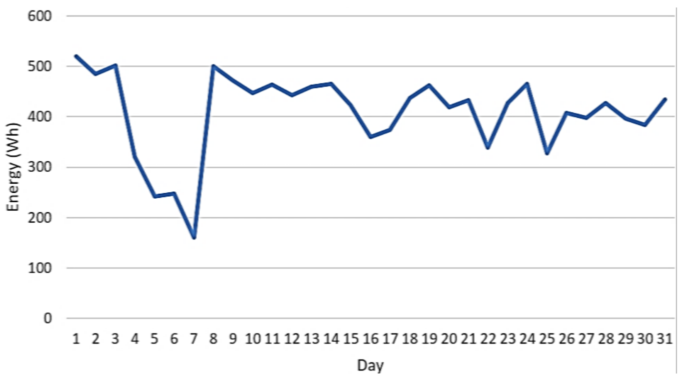

Figure 3. Energy output from PV installed on the fish dryer

3.2. Socio-economic testing of the use of fish dryer

In the Table 2, it can be seen the results of the paired t-test on the social impact of using fish dryers on fishermen. The significance value was 0.000 ($p<0.05$), meaning that there was a significant difference between the average social impact of using fish dryers before and after use. If the social impact of using a fish dryer does not differ between before and after use, then the probability factor can explain 0.00% to obtain an average difference of 5.37. Because the opportunity to explain the results obtained is <5%, then these results are significant. The results also show that from the results of the analysis, 95% confidence is obtained, where if measurements are made on the population, the difference in social impacts before and after the use of fish dryers is between 4,820-5,921. The variables discussed in this social impact are safety, cleanliness, and land use of the fish dryer.

In the Table 3, it can be seen that the results of the paired t-test have shown the economic impact of using fish dryers on fishermen. The significance value was 0.000 ($p<0.05$), meaning that there was a significant difference between the average economic impact of using fish dryers before and after use. If the economic impact of using a fish dryer does not differ between before and after use, then the probability factor can explain 0.00% to obtain an average difference of 7.96. Because the opportunity to explain the results obtained is <5%, then these results are significant. The results also show that from the analysis, 95% confidence is obtained, where if measurements are made on the population, the difference in social impacts before and after the use of fish dryers is between 6.99-8.94. The variables discussed in this economic impact are additional income earned by fishermen, efficiency, operational costs, and employment opportunities.

Table 2. Paired t-test results social impact of using fish drying machine

	n	Mean±s.d	Mean Difference±s.d	95% Confidence Interval	P
Social impact before using fish drying machine	27	10.07±1.07	5.37±1.40	4.82 – 5.92	< 0.005
Social impact after using fish drying machine	27	15.44±1.31			

Table 3. Paired t-test results economic impact of using fish drying machine

	n	Mean±s.d	Mean Difference±s.d	95% Confidence Interval	p
Economic impact before using fish drying machine	27	11.11±1.72	7.96±2.46	6.99 – 8.94	<
Economic impact after using fish drying machine	27	19.07±1.54			0.005

The results of using fish dryers by the fishermen were also analyzed by frequency distribution. These results were obtained based on several criteria, such as the fishermen's perception of the tool, the appropriateness of the tool's use, the benefit factor, and the shape of the fish dryer. If viewed from the fishermen's perception of the tool, it gives an average value of 4.67, which means that this assistance program is suitable for fishermen. The value of fishermen's perceptions of the effectiveness of the tool program is 5.26, which means that this tool is very suitable for fishermen. The value of fishermen's perceptions of the tool's usefulness factor is 5.19, which means that this tool is very suitable for fishermen. The value of fishermen's perceptions of the shape of the fish dryer is 4.19, which means that this tool is suitable for fishermen. The frequency distribution table can clearly be seen in the Figure 4.

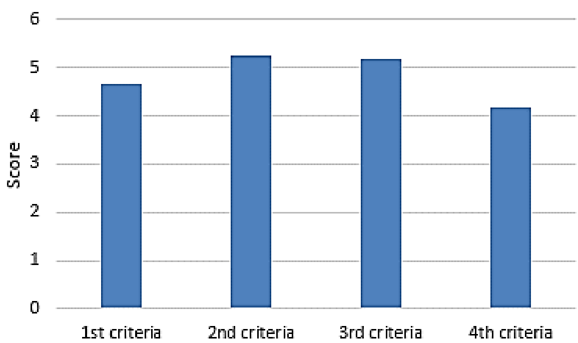

Figure 4. Fishermen's perception on the use of fish dryers

4. CONCLUSION

The utilization of PV systems in fish dryers can meet the needs for electrical energy. This PV system can meet 169.95% of the need for 240 Wh/day of electrical energy from fish dryers. PV system can produce electrical energy for 407.81 Wh/day, where the largest energy can reach 520 Wh and the smallest is 160.8 Wh. The difference in output energy produced is caused by several environmental factors, including air temperature, wind speed, and air humidity around the installation location of the fish dryer. The results of the analysis of the impact of using fish dryers socially and economically also gave significant results ($p<0.005$), where there was an increase from before and after the use of fish dryers experienced by fishermen. When viewed from the perspective of fishermen on the tool, the accuracy of the use of the tool, the benefit factor, and the shape of the fish dryer, the fishermen gave a good response, with an average value of 4.19-5.26.

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REFERENCES

[1] L. Gasco *et al.*, "Insect and fish by-products as sustainable alternatives to conventional animal proteins in animal nutrition," *Italian Journal of Animal Science*, vol. 19, no. 1. 2020, doi: 10.1080/1828051X.2020.1743209.
[2] R. Luthada-Raswiswi, S. Mukaratirwa, and G. O'brien, "Animal protein sources as a substitute for fishmeal in aquaculture diets: A systematic review and meta-analysis," *Applied Sciences*, vol. 11, no. 9. 2021, doi: 10.3390/app11093854.
[3] F. Zhubi-Bakija *et al.*, "The impact of type of dietary protein, animal versus vegetable, in modifying cardiometabolic risk factors: A position paper from the International Lipid Expert Panel (ILEP)," *Clinical Nutrition*, vol. 40, no. 1, pp. 255-276, 2021, doi: 10.1016/j.clnu.2020.05.017.
[4] I. Khan, V. I. Kaur, and S. N. Datta, "Effect of fish silage supplemented diets on growth and health status of pangas catfish, pangasianodon hypophthalmus fry," *Indian Journal of Animal Research*, vol. 55, no. 3, 2021, doi: 10.18805/ijar.B-3954.
[5] A. M. Duarte, F. Silva, F. R. Pinto, S. Barroso, and M. M. Gil, "Quality assessment of chilled and frozen fish—Mini review," *Foods*, vol. 9, no. 12. 2020, doi: 10.3390/foods9121739.
[6] P. K. Prabhakar, S. Vatsa, P. P. Srivastav, and S. S. Pathak, "A comprehensive review on freshness of fish and assessment: Analytical methods and recent innovations," *Food Research International*, vol. 133. 2020, doi: 10.1016/j.foodres.2020.109157.
[7] N. Nakazawa and E. Okazaki, "Recent research on factors influencing the quality of frozen seafood," *Fisheries Science*, vol. 86, 2020, doi: 10.1007/s12562-020-01402-8.
[8] D. T. N. Huy, V. Q. Nam, H. T. Hanh, P. N. Minh, and L. T. T. Huong, "A review and further analysis on seafood processing and the development of the fisPangasius from the food industry perspective," *Food Science and Technology (Brazil)*, vol. 42. 2022, doi: 10.1590/fst.76421.
[9] R. G. D. R. Jayawickrama, A. Wanasinghe, and U. A. Jayawardena, "Present status of smoked fish processing at Mahakanadarawa reservoir in Mihintale, Sri Lanka," *Sri Lanka Journal of Aquatic Sciences*, vol. 27, no. 1, pp. 25-30, 2022, doi: 10.4038/sljas.v27i1.7594.
[10] B. P. Dasanayaka, Z. Li, S. N. Pramod, Y. Chen, M. U. Khan, and H. Lin, "A review on food processing and preparation methods for altering fish allergenicity," *Critical Reviews in Food Science and Nutrition*, vol. 62, no. 7. 2022, doi: 10.1080/10408398.2020.1848791.
[11] T. Aspevik *et al.*, "Valorization of Proteins from Co- and By-Products from the Fish and Meat Industry," *Topics in Current Chemistry*, vol. 375, no. 3. 2017, doi: 10.1007/s41061-017-0143-6.
[12] P. Dawson, W. Al-Jeddawi, and N. Remington, "Effect of Freezing on the Shelf Life of Salmon," *International Journal of Food Science*, 2018, doi: 10.1155/2018/1686121.
[13] V. Alex Sotola, C. A. Craig, P. J. Pfaff, J. D. Maikoetter, N. H. Martin, and T. H. Bonner, "Effect of preservation on fish morphology over time: Implications for morphological studies," *PLoS One*, vol. 14, no. 3, 2019, doi: 10.1371/journal.pone.0213915.
[14] T. Tsironi, D. Houhoula, and P. Taoukis, "Hurdle technology for fish preservation," *Aquaculture and Fisheries*, vol. 5, no. 2, pp. 65-71, 2020, doi: 10.1016/j.aaf.2020.02.001.
[15] S. H. Chang *et al.*, "Antibacterial activity of chitosan–polylactate fabricated plastic film and its application on the preservation of fish fillet," *Polymers.*, vol. 13, no. 5, 2021, doi: 10.3390/polym13050696.
[16] A. Mahmud, B. Abraha, M. Samuel, W. Abraham, and E. Mahmud, "Fish preservation: a multi-dimensional approach," *MOJ Food Processing & Technology*, vol. 6, no. 3, pp. 303-310, 2018, doi: 10.15406/mojfpt.2018.06.00180.
[17] X. Nie, R. Zhang, L. Cheng, W. Zhu, S. Li, and X. Chen, "Mechanisms underlying the deterioration of fish quality after harvest and methods of preservation," *Food Control*, vol. 135. 2022, doi: 10.1016/j.foodcont.2021.108805.
[18] S. Sultana Marine, A. Sayeed, P. P. Barman, R. Begum, M. Hossain, and T. Alam, "Traditional methods of fish drying: An explorative study in Sylhet, Bangladesh," *International Journal of Fishery Science and Aquaculture*, vol. 2, no. 1, pp. 028-035, 2015.
[19] O. A. Akinola, A. A. Akinyemi, and B. O. Bolaji, "Evaluation of Traditional and Solar Fish Drying Systems towards Enhancing Fish Storage and Preservation in Nigeria: Abeokuta Local Governments as Case Study," *Journal of Fisheries International*, vol. 1, no. 3, 2006.
[20] M. Fahmi Izdiharrudin, "Heat Transfer Analysis of Solar Fish Drying Machine on the Effects of Fish Mass and Blower Speed Variations," *Am. J. Mod. Energy*, vol. 5, no. 2, 2019, doi: 10.11648/j.ajme.20190502.13.
[21] S. K. Dey, M. R. Hossain, F. A. Flowra, S. Sultana, and R. Akter, "Study of traditional fish drying activities at Atrai upazilla of Naogaon district in Bangladesh," *Asian Journal of Medical and Biological Research,*, vol. 2, no. 4, 2017, doi: 10.3329/ajmbr.v2i4.31010.
[22] N. S. B. Rukman *et al.*, "Electrical and thermal efficiency of air-based photovoltaic thermal (PVT) systems: An overview," *Indonesian Journal of Electrical Engineering and Computer Science.*, vol. 14, no. 3, 2019, doi: 10.11591/ijeecs.v14.i3.pp1134-1140.
[23] I. M. A. Nugraha, F. Luthfiani, G. Sotyaramadhani, A. Widagdo, and I. G. M. N. Desnanjaya, "Technical-economical assessment of solar PV systems on small-scale fishing vessels," *International Journal of Power Electronics and Drive Systems*, vol. 13, no. 2, pp. 1150-1157, 2022, doi: 10.11591/ijpeds.v13.i2.pp1150-1157.
[24] A. A. Firdaus, R. T. Yunardi, E. I. Agustin, T. E. Putri, and D. O. Anggriawan, "Short-term photovoltaics power forecasting using Jordan recurrent neural network in Surabaya," *Telecommunication, Computing, Electronics and Control*, vol. 18, no. 2, pp. 1089-1094, 2020, doi: 10.12928/TELKOMNIKA.v18i2.14816.
[25] I. G. M. N. Desnanjaya and I. M. A. Nugraha, "Design and control system of sluice gate with web-based information," in *International Conference on Smart-Green Technology in Electrical and Information Systems*, 2021, pp. 52–57, doi: 10.1109/ICSGTEIS53426.2021.9650409.

[26] I. G. M. N. Desnanjaya and I. M. A. Nugraha, "Portable waste capacity detection system based on microcontroller and website," in *Journal of Physics: Conference Series*, 2021, vol. 1810, no. 1, doi: 10.1088/1742-6596/1810/1/012001.

[27] I. G. M. N. Desnanjaya, I. M. A. Nugraha, I. W. D. Pranata, and W. Harianto, "Stability Data Xbee S2b Zigbee Communication on Arduino Based Sumo Robot," *Journal of Robotics and Control*, vol. 2, no. 3, 2021, doi: 10.18196/jrc.2370.

[28] R. Ghazali, "Acceleration of maritime development in Indonesia," *International Journal of Sustainability Policy and Practice*, vol. 16, no. 1, 2020, doi: 10.18848/2325-1166/CGP/v16i01/51-63.

[29] A. Phelan, L. Ruhanen, and J. Mair, "Ecosystem services approach for community-based ecotourism: towards an equitable and sustainable blue economy," *Journal of Sustainable Tourism*, vol. 28, no. 10, 2020, doi: 10.1080/09669582.2020.1747475.

[30] M. M. Taebenu, "Blue Grabbing Amidst The Application Of Blue Economy," *Journal Ilmu Pemerintah. Suara Khatulistiwa*, vol. 5, no. 2, 2020, doi: 10.33701/jipsk.v5i2.1380.

[31] D. A. A. Sari and S. Muslimah, "Blue economy policy for sustainable fisheries in Indonesia," in *IOP Conference Series: Earth and Environmental Science*, 2020, vol. 423, doi: 10.1088/1755-1315/423/1/012051.

[32] R. A. Praptiwi *et al.*, "Tourism-based alternative livelihoods for small island communities transitioning towards a blue economy," *Sustainability*, vol. 13, no. 12, 2021, doi: 10.3390/su13126655.

[33] Sumarmi, E. Kurniawati, and M. Aliman, "Community based tourism (cbt) to establish blue economy and improve public welfare for fishing tourism development in klatak beach, tulungagung, indonesia," *GeoJournal of Tourism and Geosites*, vol. 31, no. 3, 2020, doi: 10.30892/gtg.31307-530.

[34] I. G. M. N. Desnanjaya, I. M. A. Nugraha, I. B. G. Sarasvananda, and I. B. A. I. Iswara, "Portable waste based capacity detection system using android based arduino," in *International Conference On Smart Cities, Automation & Intelligent Computing Systems*, 2021, doi: 10.1109/icon-sonics53103.2021.9617000.

[35] O. Al-Mahmud, K. Khan, R. Roy, and F. Mashuque Alamgir, "Internet of things (IoT) based smart health care medical box for elderly people," *International Conference for Emerging Technology,* 2020, doi: 10.1109/INCET49848.2020.9153994.

[36] N. K. Kasim, N. M. Obaid, H. G. Abood, R. A. Mahdi, and A. M. Humada, "Experimental study for the effect of dust cleaning on the performance of grid-tied photovoltaic solar systems," *International Journal of Electrical and Computer Engineering*, vol. 11, no. 1, pp. 74-83, 2021, doi: 10.11591/ijece.v11i1.pp74-83.

[37] S. A. Tadjer, A. Idir, and F. Chekired, "Comparative performance evaluation of four photovoltaic technologies in saharan climates of Algeria: Ghardaïa pilot station," *International Journal of Electrical and Computer Engineering*, vol. 18, no. 2, 2020, doi: 10.11591/ijeecs.v18.i2.pp586-598.

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