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The Design of Solar-Powered Lighting Aid Tool for Swimming Crab (*Portunus pelagicus*) Fishing – 'SuryaNet' – as an Effort to Preserve Environmental Sustainability

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Abstract

Currently, there is a need to develop an attractor that utilizes solar energy as a renewable and sustainable energy resource, as an alternative to reduce dependency on the use of solar fuel or gasoline for fishing operations. The research objective is to create a prototype design for a solar-powered lighting aid tool for capturing swimming crab (*Portunus pelagicus*) named SuryaNet as an effort to promote environmental sustainability. The method used in this research was experimental, involving the creation of a prototype design for a solar-powered lighting aid tool for capturing the swimming crabs (*Portunus pelagicus*) on the gillnet fishing vessel 'SuryaNet' and in-depths interview with fishermen as the basis for designing the tool. The prototype design of the solar-powered lighting aid tool for fishing swimming crab (*Portunus pelagicus*) named 'SuryaNet' can be created as an effort to maintain environmental sustainability and be more environmentally friendly. SuryaNet is a series of components consisting of four parts, namely: (1) the solar panel section, (2) the SuryaNet charging dock, (3) the underwater light and (4) the ship's lighting system that can be placed on fishing vessels, designed to meet the needs of fishermen, and used during fishing operations.

Keywords: environment, solar energy, lighting, swimming crab.

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Introduction

Indonesia is a tropical country that receives sunlight exposures throughout the year. The sun as a renewable energy resource is utilized to bolster public activity as a source of electrical energy. At this time, fishermen are employing solar fuel or gasoline as an energy resource to power their fishing boats and carry out fishing operations. Surabaya has a relatively high fisheries potential with the presence of gillnet fisherman below 10 Gross Tonnage (GT). The type of gillnet vessels used by fishermen in the eastern waters of Surabaya is for capturing the marine resources known as swimming crab (*Portunus pelagicus)*, which can be caught at depths of 5-10 meters (Syah et al., 2023). Swimming crab (*Portunus pelagicus*) is a fishery commodity with a relatively high selling point, both as local commodities or export commodities. Swimming crab ranks third in exports after shrimp and tuna, which has an increasing export value every year (Fisheries, 2022; Zanghellini & Eigenfeld, 2022).

Currently, there is a need to develop an attractor that utilizes solar energy as a renewable and sustainable energy resource, as an alternative to reduce dependency on the use of solar fuel or gasoline for fishing operations. The latest studies indicate that swimming crabs respond positively to lights as attractant in their fishing operation (Hasly, Yusfiandayani, & Mawardi, 2019), hence there needs to be innovation to assist

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fishermen, particularly in the eastern waters of Surabaya, by creating a solar-powered lighting tool prototype for fishing swimming crabs (*Portunus pelagicus*) named SuryaNet with the hope that it will optimize swimming crab fishing operation conducted at night, thereby reducing the cost of using BBM (bahan bakar minyak) or diesel fuel. The research is an advanced applied study related to the design of eco-friendly fishing boats using solar-powered electric motors (Dewantara, 2019), resulting in an output in the form of solar-powered electric motor design. The alternating use of solar energy on fishing vessels can minimize operational costs (Shanty, Ayom, & Muhammad, 2021). Research on attractor is highly essential in order to improve the catch results of gillnet fishermen (Adham et al., 2022; Nurul Rosana & Rifandi, 2018a).

The research problem statement is the increasing cost of diesel fuel used in swimming crab fishing operations, therefore there is a need for an attractor that can reduce the use of diesel fuel by utilizing solar energy. Further research and studies are highly necessary to create an attractor by utilizing solar energy sources as an effort to reduce the dependance on the currently used fuel, thus reducing the operational costs of fishing swimming crabs (*Portunus pelagicus*). The research objective is to create a prototype design for a solar-powered lighting aid tool for fishing swimming crab (*Portunus pelagicus*) named SuryaNet as an effort to promote environmental sustainability (Hu, Liang, & Huang, 2022).

Research Methodology:

The research was conducted from May to October 2023, spanning 6 months. The research location was in the eastern waters of Surabaya, chosen based on the consideration that the majority of fishermen in that area operated gillnet fishing gear and engaged in swimming crab-fishing activities during the nighttime.

The materials or data used in this research include: the boat and gillnet fishing gear, as well as the materials for the design and construction of the prototype lighting aid tool for fishing swimming crabs (*Portunus pelagicus*) based on solar energy, known as 'Surya Net'. The primary data used as the basis for designing the tool includes the composition of swimming crab catches, the condition of the waters, and the duration of electricity usage during the fishing operation. The secondary data used consisted of the results of in-depths interviews with 50 fishermen who were engaged in swimming crab-fishing activities. The method used in this research was experimental, involving the creation of a prototype design for a solar-powered lighting aid tool for fishing the swimming crabs (*Portunus pelagicus*) on the gillnet fishing vessel 'Surya Net'.

Results and Discussions:

Research focused on the use of solar energy as an effort to address the energy crisis by reducing dependency on fossil energy sources and utilizing alternative energy resources has been conducted by several researchers before. In the initial stage of research a study was conducted to identify traditional fishing boats known as gillnet vessels in the eastern waters of Surabaya (Nurul Rosana et al., 2023) and design of environmentally friendly fishing boats using solar-powered electric motors, which produces the output of solar-powered motor design, as well as research on attractor (N Rosana, 2017; Nurul Rosana & Rifandi, 2018b). Study of solar panels as a power generator for the lighting system of fishing boats (Sardi, Pulungan, Risfendra, & Habibullah, 2020), was conducted to reduce fishermen's reliance on conventional fuels. The working principle of the innovation to be developed involves using a solar panel as an absorber of solar energy, converting it into electrical energy to charge a battery.

Additionally, there is a charge control unit that functions to stabilize the voltage from the solar panel and manage the power supply to the lighting load, helping in the fishing of swimming crab resources. The current swimming crab fishing operations still utilize different types of fish bait using simple tools (N Rosana, Djanat, & Mukminin, 2020; Sofijanto & Subagio, 2022) and light to attract the swimming crabs' attention (Arimoto,

2013) using various colors (Bryhn, Königson, Lunneryd, & Bergenius, 2014) with gasoline or solar fuel as their energy resource. The data from interviews with swimming crab fishermen who use gillnet fishing gear (figure 1) include the following: (1) the vessels used are below 5 GT in size with a 9 horsepower (HP) engine, (2) they carry out the fishing operations at night, starting at 19:00 WIB and continuing until 05:00 WIB the following day, (3) the average number of nets used is 17-22 pieces with a total length of 20 meters, (4) the fishing operations are carried out by 2 fishermen, (5) the water depth during net deployment is 5 meters from the sea surface, (6) the lightning equipment used during the fishing operation is LED lamps with a power of 20 watts, (7) the energy source is an accumulator (battery), (8) the fuel oil (gasoline) needed for the duration of lighting during fishing operation is 5 liters and (9) swimming crab catches, sold in fresh form after each fishing operation, averages around 6-10 kilograms, with a selling price ranging from Rp. 20,000 to Rp. 30,000 per kilogram (Suresh, Sameer, & Susan, 2022).

Figure 1. Data Collection from Swimming Crab Fishermen in the Eastern Waters of Surabaya

Prototype Design of SuryaNet

Based on the in-depth interview with the fishermen, a prototype design for a solar-powered lighting aid tool for fishing swimming crab (*Portunus pelagicus*) named 'Surya Net' was subsequently developed. Surya Net is a series of components consisting of four parts, namely: (1) the solar panel section, (2) the SuryaNet charging dock, (3) the underwater light and (4) the ship's lighting system. Design and placement of SuryaNet on the gillnet fishing vessel can be seen in Figure 2. The first part is a solar panel that is used to capture solar energy which then will be used as the power source in the system. The second part is a charging dock that is a box-shaped panel that serves to recharge the underwater lights. The third part is the underwater light, which functions to emit light within the water during fishing operations to enhance the swimming crab fishing yield. The fourth part is the lighting system, which is used for illumination on the gillnet fishing vessel.

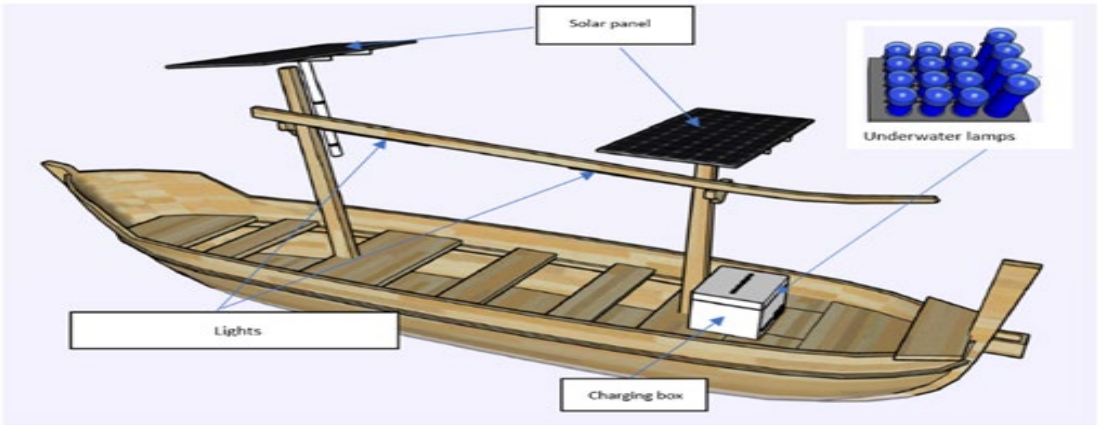

Figure 2. Surya Net System Placed on the Gillnet Fishing Vessel

The design and specifications of Surya Net charging dock are as shown in Figure 3, which includes components such as control for charging the underwater light vessel lighting, whereas in this section there are batteries, solar panel control devices, protective components, output socket serving as an electrical supply for lighting on the fishing vessel, with the output from this socket being electrical energy with a voltage of 220 VCA and portable underwater lights (fishermen's net lights) that can be recharged using the dock system on the Surya Net tool.

Figure 3. Charging Dock Design

In detail, the specifications of the Surya Net system are as follows:

a) charging dock circuit (figure 3), which consists of:
   1. a control circuit for charging the underwater lights and the above-deck vessel lighting
   2. an output socket as a source of electrical power for above-deck vessel lighting and other needs
   3. portable underwater lights that can be recharged using the Surya Net tool's dock system
   4. the charging dock which is a device for recharging the electrical energy of the underwater lights and includes a LiPo battery charger
   5. the charging dock socket used for recharging the electrical energy of the underwater lights.

b) Underwater lights (figure 4), consists of:
   1. an electronic circuit, comprising a 3-watt LED light, and one 1K ohm resistor
   2. a 3-cell battery with a capacity of 2200 mAh
   3. the device body with the following dimensions: height 23 cm, diameter 5 cm, at the bottom/back there is a socket for recharging electrical energy and a switch for turning the light on and off, at the front/top there is an LED light and a resistor. The body is blue in color, and the front is translucent. The blue part is made from PP plastic, while the translucent part is made from HI material.

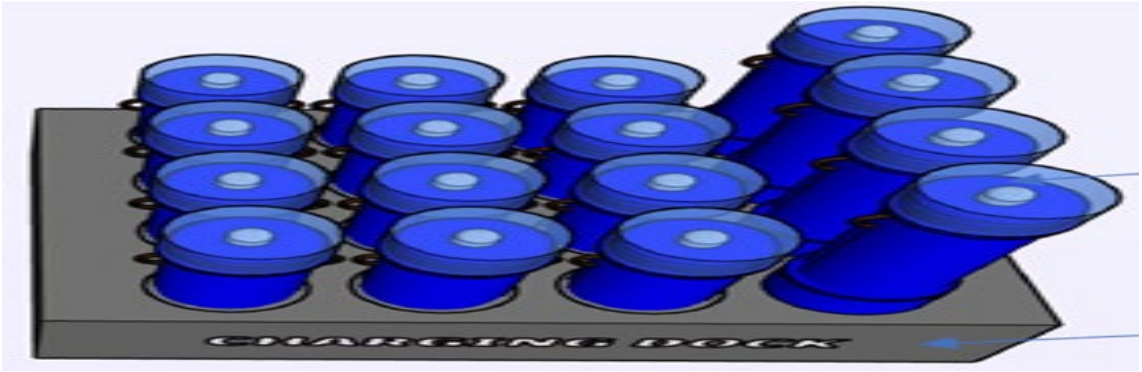

Figure 4. Underwater Light

c) Solar panel circuit (figure 5), consists of:
   1. Two units of solar panels, each with an output capacity of 150 kWp, and two solar panel mounting brackets
   2. A set of electrical cables to connect the solar panels to the charging dock

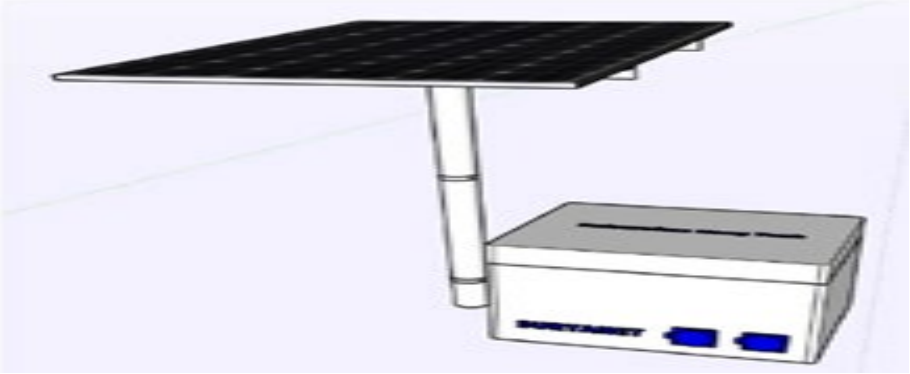

Figure 5. Solar Panel

d) Two vessel lighting lamps, each with a capacity of 10 watts

The design of Surya Net as a solar-powered lighting aid tool for swimming crab fishing is a highly positive and environmentally friendly innovation, which is expected to reduce the use of oil fuel during the fishing operations and improve the swimming crab catches for gillnet fishermen.

Conclusion:

The prototype design of the solar-powered lighting aid tool for fishing swimming crab (*Portunus pelagicus*) named 'Surya Net' can be created as an effort to maintain environmental sustainability and be more environmentally friendly. Surya Net is a series of components consisting of four parts, namely: (1) the solar panel section, (2) the SuryaNet charging dock, (3) the underwater light and (4) the ship's lighting system that can be placed on fishing vessels, designed to meet the needs of fishermen, and used during fishing operations.

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