



# The Darrieus-Savonius Wind Turbine Development as an Icon of Marine and Culinary Tourism in Belawan

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## ABSTRACT

The Darrieus-Savonius combination wind turbine is often chosen to power streetlights in coastal areas. In this community partnership program (PKM), the primary function of the wind turbine, which is a renewable energy power generator, is slightly shifted to serve as an icon of marine tourism and culinary in the coastal city of Medan, especially in the Medan Belawan sub-district. The main objective of this program is to increase revenue from marine tourism and culinary spots through culinary icons. The culinary icon offered to the community is a wind generator that can operate at low wind speeds, ranging from -1.5 m/s to a maximum of 45 m/s, which is well-suited for installation in Belawan, near the public pier of the Titi Panjang Bridge. Through this activity, which applies the technology-as-a-service model, the public pier will be illuminated with decorative lights powered by electricity from the wind turbine installed near the community restaurant. The process of selecting the location and type of wind turbine is explained using the decision matrix method. The subject of this program is the Marine Cafe, which is one of the restaurants on the edge of the Titi Panjang Bridge. The construction of wind turbines and their benefits for PkM partners are presented, based on sales data showing a 15-20% revenue increase, which provides an opportunity to increase revenue and develop the PkM partner business in the long term.

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## Introduction

In tourism promotion, creating icons is a crucial marketing strategy, serving as attractions or must-sees for a tourist destination. The importance of icon creation is readily apparent in almost every major city in the world. Paris is the Eiffel Tower, New York the Statue of Liberty, China the Forbidden City or the Great Wall, London Big Ben, Kuala Lumpur the Twin Towers, and Jakarta the National Monument. These are just a few examples of cities with tourist icons.

The role of icons as visitor attractors has been explored using big data (Becken, 2005). One conclusion is that tourist cities need to develop destination marketing campaigns, with attention to



promoting both iconic and non-iconic activities. The balance between iconic and non-iconic activities will largely depend on the potential size of the repeat market and the destination's desire to enter it.

Taufiq and Parera conducted community service programs on the use of renewable energy systems, utilizing water and solar energy, respectively (Taufiqurrahman & Windarta, 2020; Parera et al., 2019). Unik in Mandiangan Siak implemented automation and monitoring devices, while Pratama conducted a 1,400-watt inverter efficiency test on a household renewable energy system (Unik, 2019). Citasary in Belasari village utilized cow dung for renewable energy, while Azzara analyzed financial management and financing for entrepreneurship development (Wardhana et al., 2024), (Aghitsni & Busyra, 2022).

A previous academic review was conducted by Keller, Lane & Hoeffler (2003), who documented the various benefits of branding, which, in this case, is also a marketing strategy. They documented 8 benefits of branding in marketing, namely: (a) Improved product performance perception, (b) Greater customer loyalty, (c) Less vulnerability to competitive marketing actions and marketing crises, (d) Wider margins, (e) More elastic customer response to price reductions and less elastic customer response to price increases, (f) Greater trade and intermediary cooperation and support, (g) Increased effectiveness of marketing communications, (h) Additional licensing and brand extension opportunities.

A study of the effectiveness of tourism icons in tourism in the United States and China. Using three situational factors, namely culture, history, and government involvement, as criteria in measuring tourism success. Using a survey method, they concluded that the development of icons as tourist attractions in China is more influential than in the United States, with various detailed explanations (Tang et al., 2009). Research on marine tourism in Sakti Village, Nusa Penida District, Klungkung Regency, using SWOT analysis. I Gede Anom Sastrawan explained the strategy for developing tourism potential based on the natural and artificial physical potential of Crystal Bay Beach, but unfortunately, there was no discussion of how to make one of the natural or artificial physical potentials into a tourist icon (Sastrawan & Sunarta, 2014). Investigations on the application of hybrid renewable energy systems in the industrial sector have been conducted by researchers (Pranckevičius et al., 2025).

As a marketing strategy for developing marine and culinary tourism in Medan, the Medan Belawan sub-district was chosen. Its primary advantage is its year-round strong winds, offering the potential for marine and culinary tourism development. This community service program offers a solution to increase local income by developing a wind-turbine tourism icon. The resulting electricity can be used for lighting, particularly at the Titi Panjang public pier, and to increase revenue for culinary micro, small, and medium enterprises (MSMEs).

## Methods



A community service method for implementing science and technology, in this case, the use of wind turbines as culinary icons. The application of Appropriate Technology (TTG) creates simple, affordable, and easy-to-use technology that can help increase culinary income in the Belawan community. Activities are divided into selecting the location and type of wind turbine, carried out using the decision matrix method (Pugh 1990). This method is commonly used in engineering to inform product design decisions, but can also be applied to various other purposes. Using a 5-point scale ranging from 0 to 4, certain criteria are ranked, and ultimately, the sum with the highest value is considered the best.

Three locations for wind turbine construction will be selected, namely (1) Belawan passenger and cargo port, (2) Titi Panjang ferry dock, and (3) Gabeon fishing port. These three locations have advantages and disadvantages that will be selected based on 6 (six) criteria that are considered appropriate, as shown in the objective tree in Figure 1(a). The quality factor in this objective tree is divided into three parts: benefit factor (50%), cost factor (25%), and service factor (25%).

The benefit factor emphasizes the wind turbine's usefulness for marine/culinary tourism and the surrounding community. The cost factor comprises manufacturing/purchase, installation, and maintenance costs. The final factor, service, is durability and manufacturing time. To select the turbine type, three types of wind turbines are compared: vertical, horizontal, and a Darrieus-Savonius combination. These three types will be selected based on six criteria, as shown in the objective tree in Figure 1(b).

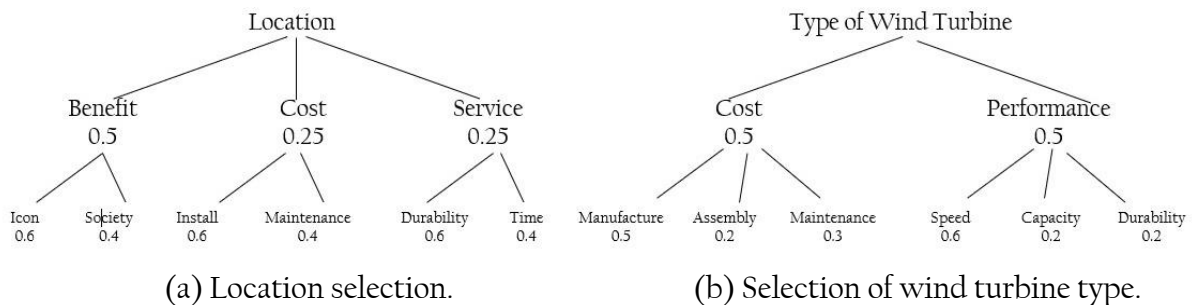


Figure 1. Objective tree for selecting wind turbine location and type.

Selection is based on cost and performance, with equal weighting. In terms of cost, the largest factor is manufacturing/purchase, followed by installation and maintenance. For performance, wind speed is the most important factor in the selection criteria. Wind turbine capacity and durability are given equal weighting.

After the process of selecting the location and type of wind turbine is completed, the wind turbine is constructed at the Marine Cafe, the PkM subject. Construction of the turbine took three months in early 2025, and the impact of the construction was evaluated in late 2025.

## Results

### Results of location selection analysis

The complete results of the location selection analysis are shown in Table 1. The weighting factor for each selection criterion is obtained by multiplying the quality factors shown in Figure 1. For example, the weighting factor for the benefits for tourist icons is  $O1 = 0.6 \times 0.5 \times 1.0 = 0.3$ , and so on for all weighting factor calculations. The location of the people's pier, the Titi Panjang crossing, received the highest score of 3.35, followed by the Gabeon fishing port at 3.25 and the Belawan passenger and cargo port at 3.0. From this selection analysis, the people's pier at the Titi Panjang crossing was chosen with the service partner Marine Cafe.

### Results of analysis of wind turbine type selection

With the average wind speed in Titi Panjang, measured directly or using BPS data (2019), ranging from 1.5 to 3.5 m/sec, the horizontal wind turbine type will receive the lowest rating.

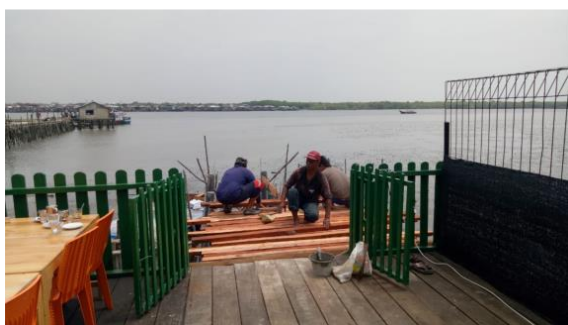
Analysis of the six criteria yielded the highest score for the Darrieus-Savonius wind turbine, at 3.35. However, vertical wind turbines are also worth considering because their scores are not significantly different. The full results can be seen in Table 2.



(a) View from Google Maps.



(b) Wind turbine location.



(c) View from inside the restaurant.



(d) View from Titi Panjang pier.

Figure 2. The location of the wind turbine as an icon of culinary and marine tourism.



Rak

(c) Battery

(c) Battery.

(d) Inverter.



(a) Support pillar. (b) Wind turbine. (e) Controller.

Figure 3. Poles, wind turbines and supporting accessories.

### Wind Turbine Construction

The wind turbine was constructed behind the Marine Café, facing the sea, next to the people's pier in Titi Panjang, as shown in Figure 2. The foundations for a pair of wind turbine masts were built on the side of the marine tourism pier, which is currently under construction, Figures 2(b) and 2(d).

A 1-meter-deep pile foundation is embedded in the seashore with the aim of being strong enough to withstand the pounding of waves and corrosion. The resulting electric current is used as a source of electricity for the surrounding community, in this case, the lights at the Marine Café and the LED lights that stretch along the Titi Panjang pier.

The support pole is 9 meters high, with a wind turbine installed at the top. This wind turbine will rotate and generate electricity, which is connected to a controller. This controller regulates the amount of electricity entering the battery during charging. An automatic OFF option is available if the battery has sufficient current, and an ON option if the current is insufficient.

Criteria	Weighting Factors	Belawan Passenger and Cargo Port			Titi Panjang Crossing People's Pier			Gabeon Fishing Port		
		Magnitude	Number	Mark	Magnitude	Number	Mark	Magnitude	Number	Mark
Benefits for tourism icons	0,3	Low	2	0,6	Very high	4	1,2	High	3	0,9
Benefits for society	0,2	Low	2	0,4	Very high	4	0,8	Very high	4	0,8
Installation costs	0,15	Cheap	4	0,6	Expensive	2	0,3	Currently	3	0,45
Maintenance costs	0,1	Cheap	4	0,4	Expensive	2	0,2	Expensive	2	0,2
Durability	0,15	Very good	4	0,6	Currently	3	0,45	Good	4	0,6
Time of creation	0,1	Fast	4	0,4	Long	4	0,4	Currently	3	0,3
RESULT		3,0			3,35			3,25		

The electric current from the battery is converted to 220 volts using an inverter. The image of the wind turbine pole and its accessories is shown in Figure 3. A pair of wind turbines with a capacity of 2 x 300 watts is expected to charge two batteries (2 x 60 Ah) to illuminate the pier throughout the night. The results of the wind turbine construction at the Marine Cafe, Belawan, are shown in Figure



4. The PkM Team representatives documented right between the two wind turbine poles shown in Figure 4(a), while many Cafe visitors were also interested in the wind turbine pole as a photo spot, as shown in Figure 4(b). From a distance, the wind turbine is shown in Figure 4(c).

Table 2. Selection of wind turbine type using decision matrix method.

Criteria	Weighting Factors	Vertical Wind Turbine			Horizontal Wind Turbine			Darrieus-Savonius Wind Turbine		
		Magnitude	Number	Mark	Magnitude	Number	Mark	Magnitude	Number	Mark
Manufacturing/Purchase Costs	0,25	Expensive	2	0,5	Cheap	4	1,0	Currently	3	0,75
Installation costs	0,1	Expensive	2	0,2	Currently	3	0,3	Currently	3	0,3
Maintenance costs	0,15	Cheap	4	0,6	Currently	3	0,45	Currently	3	0,45
Initial working speed	0,3	High	2	0,6	Currently	3	0,9	Low	4	1,2
Electrical capacity	0,1	High	4	0,4	Currently	3	0,3	Currently	3	0,3
Durability	0,1	Very good	4	0,4	Currently	3	0,3	Good	4	0,4
RESULT				2,7			3,25			3,4

### Benefits of Wind Turbine Construction

The wind turbine, as an icon, is expected to positively influence the development of culinary and marine tourism in Medan Belawan. Generally, the benefits of the wind turbine icon are divided into two parts, based on the number of program partners: the community around the pier and boat rental service providers.

For the community around the pier, the wind turbine icon is useful as: (a) Marking culinary and marine tourism locations, (b) Attracting visitors to eat and use the tour boats, (c) Additional indirect factors to increase the income of Community Service Program partner (PkM).

For boat rental service owners, it is useful as: (a) Additional lighting at the public pier for marine tourism, (b) Towing for boat users.

Observations conducted over the six months following the wind turbine's installation resulted in a 30% increase in Cafe Marine's weekend revenue. Overall, the six-month increase compared to the previous year was around 15-20%. The growth in sales volume and gross income (turnover) is shown in Table 3.

Table 3. Sales volume growth.

Month	Volume Sold (Pcs)	Total Revenue (Rp)	Percentage Increase (%)



November	490	38.000.000	-
December	635	49.200.000	29,5
January	580	44.900.000	18,2
February	590	45.700.000	20,3
March	560	43.400.000	14,2
April	590	45.700.000	20,3

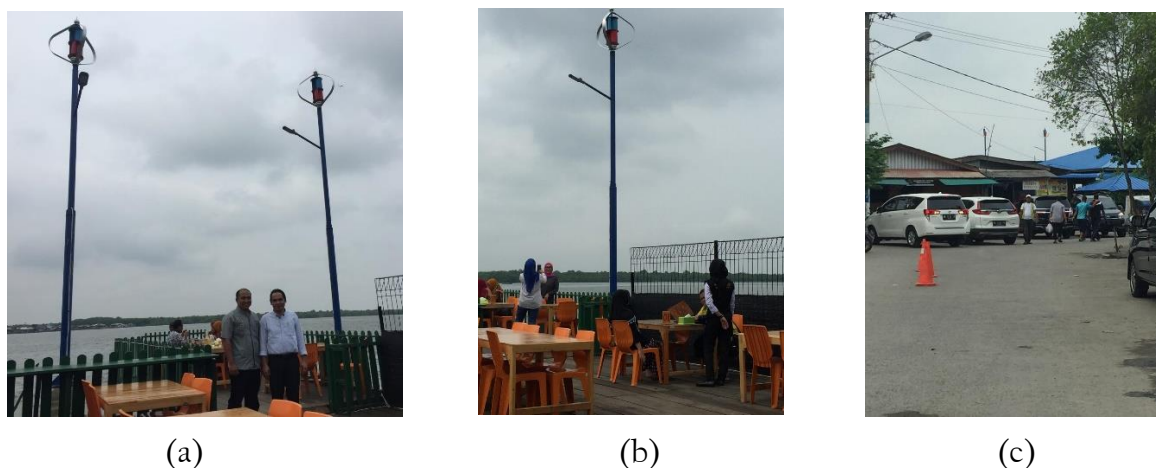


Figure 4. Documentation of activity results, (a) PkM Team Representative, (b) Visitor photo spot, (c) View of wind turbine icon from a distance.

### Conclusion

This community service program has successfully built two wind turbines that serve as icons of marine and culinary tourism in Medan Belawan. The process for selecting the location and type of wind turbine is explained in detail using a decision matrix. The wind turbine construction process and benefits for PkM partners are explained using sales data, which resulted in a 15-20% increase in revenue. This will create opportunities to increase revenue and support the long-term development of PkM partners' businesses. Future programs can also focus on leveraging the latest technology to support independent dock lighting, such as increasing the number of wind turbines and automating controller operations.

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