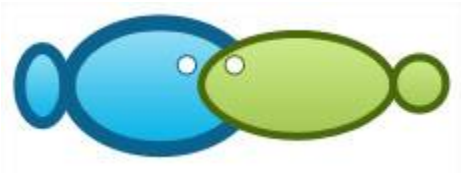

SWOT analysis in determining coastal environmental protection strategies in the Silugonggo River channel, Pati Regency

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Abstract. The increasing trend in the construction of fishing vessels in Central Java has had notable environmental and societal repercussions. Juwana Port, situated along the Silugonggo River, serves a critical role in shipping, berthing, and mooring operations. Historically, the port accommodated large fishing vessels with a Gross Tonnage (GT) of under 7. However, from the 1980s onwards, there was a shift towards the development of fishing boats with a maximum GT of 35, a trend which has continued to evolve, leading to the construction of fishing boats with a GT exceeding 60. The activities associated with these vessels on the Silugonggo River, including mooring, repairs (encompassing engine, hull, antifouling, painting, and scrubbing), significantly contribute to the pollution of river water. Additionally, waste from boats and the local fishing community exacerbates sedimentation in the surrounding river area. This research was performed to develop a conservation and management strategy for the Silugonggo River channel, aiming to safeguard the coastal environment. SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis model was used in identifying and evaluating the most effective marine management and protection strategies. The outcomes of the SWOT analysis indicate a positioning in Quadrant 1. This suggests that there is a critical need for the aggressive or pluralistic pursuit of management and protection strategies. Such efforts should aim to leverage the existing strengths and opportunities to enhance the environmental conservation of the Silugonggo River channel.
Key Words: coastal environment, EFAS-IFAS, Pati Regency, protection, sedimentation.

Introduction. The fisheries sector is a cornerstone of Indonesian national food security, as most people live in coastal areas and fish serves as the primary dietary staple in the community (Manullang et al 2022). The evolution of fishing vessels has profoundly influenced the Silugonggo River channel, a vital maritime corridor in Pati Regency. The river is instrumental in bolstering the local economy and sustaining aquatic ecosystems (Prasetiawan et al 2021). On the other side, rapid advancement in transportation sector has negatively affected the traditional shipping business (Byrnes & Dunn 2020).

Juwana Port has been a critical maritime conduit since ancient times. Historically, it served as a hub for shipping, berthing, and mooring of vessels. Initially, the port accommodated large fishing vessels with a Gross Tonnage (GT) of under 7. Starting in the 1980s, bigger fishing boats with a capacity of up to 35 GT were developed which then reached over GT 60 (data from the ship measuring register of Juwana Class III Port Operator Unit Office Year 2022).

Gross tonnage (GT) and net tonnage (NT) are measures used to quantify a ship's volume, as defined by the Republic of Indonesia Government Regulation No. 51 of 2002 on shipping. Modern ships with advanced operating systems require skillful crews

(Hannaford & Van Hassel 2021). Even more, many fishing vessels had their gross tonnage upgraded from under 35 GT to over 88 GT with an initial vessel size of 2 m x 3 m to reach an average length of 24 meters. Despite the static traffic flow and docks, the economic growth in Juwana subdistrict in 2010 has spurred the construction of vessels with larger gross tonnage. There are currently 2100 vessels registered through the ship register in Port Management Unit Class III Juwana.

The construction of fishing vessels must currently be equipped with design drawings approved by the Directorate General of Sea Transportation, including: the designation of its function, the area of operation, the age and economic value of vessels, vessels and equipment capable of operation, the strength of hull and building construction, watertight construction structures, resistance and propulsion, safety for sailors, comfort for sailors, maximum carrying and loading capacity, environmental friendliness, pollution prevention, intact stability/damaged stability, ease of maintenance, and the vessel design must meet with national regulations, international conventions, vessel classification regulations; and/or the latest developments in shipping rules (Regulation of the Minister of Transportation of the Republic of Indonesia, No. 54 of 2021 concerning Ratification of Ship Design Drawings, Implementation and Supervision of Ship Construction and Work). However, the current practices have not yet complied with the requirements, particularly in terms of waste sewage and pollution management. Business actors and ship operators often lack of knowledge and awareness regarding the importance of coastal environmental protection.

Ship activities on the Silugonggo River, such as mooring and ship repair, including engine repair, hull repair, antifouling, painting, and scrubbing contribute to the river pollution. Removal of residual lubricants and fuel oil, as well as antifouling and paint spills also pollute the water from the disposal of wood waste for ship repair (Darlan & Kamiludin 2008). Human activities along the river, such as urinating and defecating directly into the river due to the absence of essential public amenities like bathrooms and toilets worsen this condition. This situation urges serious action to mitigate pollution and enhance environmental health (Prasetiawan 2023).

Mooring ships on the Silugonggo River also impact the river ecobiology and sedimentation, leading to lower water quality and siltation. Water quality test results highlighted several alarming parameters (Arvianto et al 2016; Aina et al 2016). The pH levels were either within the bare or exceeding the standards (Rahman & Aryanto 2021). Liquid waste from diesel has been the major pollution factor, which does not only discolor the water to murky brown but also emit a foul odor. Furthermore, diesel waste is difficult to decompose, resulting in physical, chemical and microbiological degradation of the water quality around Bajo Port (Utomo et al 2013).

This research employed the SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis model in data processing and analysis. SWOT analysis combines the study of strengths and weaknesses of an organization, plan, or program with the study of opportunities and threats to help determine management strategy. This method determined the fittest strategy for marine environmental protection in the Silugonggo River channel in Pati. This research was mainly conducted to formulate a protection and management strategy in the river channel to protect the coastal environment.

Material and Method

Description of the study sites. The study was conducted on the Silugonggo River channel, with major focus on the integrated coastal environmental protection research on vessels moored at the site. The research site was limited to the Silugonggo River from Juwana Bridge to the estuary as shown in Figure 1.

Research design. This descriptive research was performed using a SWOT analysis to examine the condition of the Silugonggo River, urban ponds, harbors, vessel dimensions, vessel crews, stakeholders, and surrounding communities in the Silugonggo River channel as the objects.

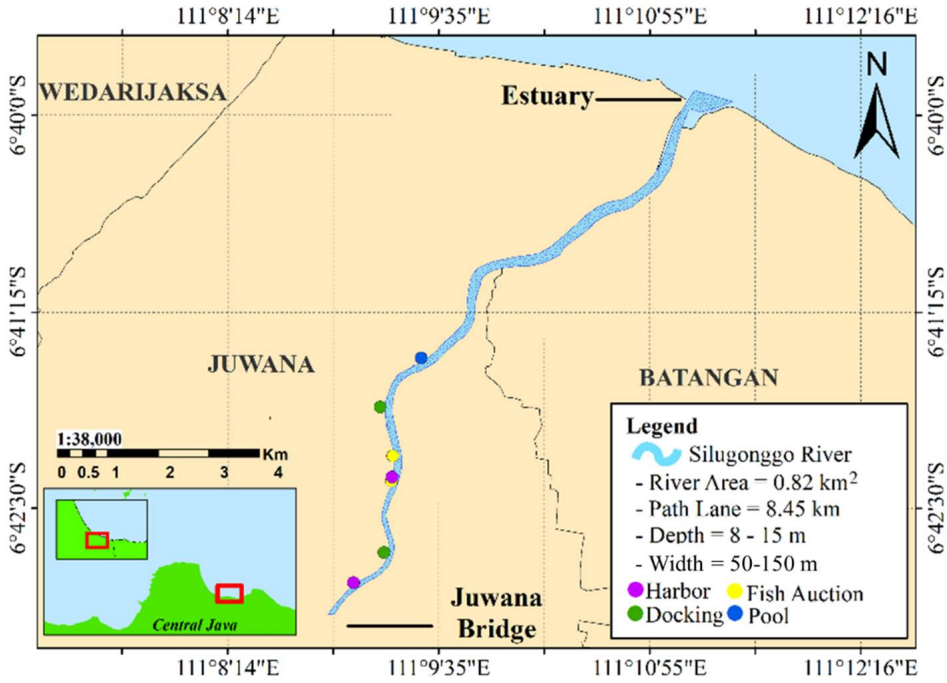

Figure 1. Silugonggo river channel research location.

Population and sample. This research involved all stakeholders related to shipping activities, ports and the Silugonggo River channel, divided into groups such as business actors (ship owners, ship operators, owners of dock and shipyard companies, and dock and shipyard workers), central managers and local governments, seafarers, policy makers, experts (professionals in the field of shipping, ports, flows, docking pools, and coastal environmental protection), and academia. Respondents were put into different groups as different data were required.

Analysis. The SWOT analysis was conducted to assess the condition of the Silugonggo River channel in the Juwana Port working area in support of coastal environmental protection. SWOT analysis assessed the resources and capabilities of an organization by measuring internal and external factors. A SWOT matrix results in 4 possible alternative strategies, namely the SO strategy, WO strategy, ST strategy and WT strategy (Windi 2021). The SWOT analysis of the Silugonggo River channel regarded both internal factors (strengths and weaknesses) and external factors (opportunities and threats).

The weighting and evaluation of these factors was crucial in formulating effective strategies. Internal and external factors were rated in a 4-point Likert scale, expressing 4 = strongly agree, score 3 = agree, score 2 = slightly disagree, and score 1 = disagree. This is inversely proportional to the Weakness and Threat factors where score 4 = strongly disagree, score 3 = slightly disagree, score 2 = agree, and score 1 = strongly agree. After determining the next rating, the weight of each factor is calculated. The calculation weights were based on scale levels ranging from 0.00, which means not important, to 1.00, which means very important. weights assigned to factors within the Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) matrices were summed to produce a total score that did not exceed 1.00, adhering to a 1 to 4 scale that signified importance or strength from 'not important' to 'very important'. The internal and external factor calculation are illustrated with a Cartesian diagram, which aims to group strategic factors that can be taken into account in formulating the actions. The formula used in the determination of the coordinate point (x, y) measured the sum of the internal and external analysis as follows:

$$\text{Horizontal coordinate: } \frac{S-W}{2} \text{ ; Vertical coordinate: } \frac{O-T}{2}$$

Results. The results of the SWOT analysis to determine the internal and external factors in the Silugonggo River channel are presented in Table 1.

Table 1

Internal and external factors of Silugonggo River channel

Code	*Strength*	*Code*	*Weakness*
S1	The majority of the population in the area are engaged in the fishing industry, encompassing roles as fishermen and entrepreneurs involved in fishing vessel operations and the fish trade. This sector has witnessed a year-on-year increase in fish productivity, highlighting its significance to the local economy.	W1	Sedimentation has been found almost on both sides of the channel with a ship width of approximately 24 meters, a channel length of 8.5 km, which affects the smooth flow of ship traffic.
S2	The Air and Water Police Corps security post and naval base provides security for vessels docking or anchoring in the Silugonggo River channel, thus providing a sense of comfort and security for ship owners to moor vessels in the river channel.	W2	Siluggonggo River channel is one of the most crowded and busy shipping lanes in Pati Regency.
S3	The Silugonggo River channel is the only strategic channel which provides access for the delivery of ship spare parts, embarkation and disembarkation of crew and crew food supplies, and bunker operations.	W3	The construction of an urban pond in 2019 in the northern part of Seprapat Island cannot function well due to budget limit.
S4	Tere are commercial ports and fishing ports, commercial ports under the authority of The Ministry of Transportation for Juwana Ports as regulators are Port Management Unit Class III Juwana has 2 piers Post 1 and Post 2, for fishing ports under the Ministry of Maritime Affairs and Fisheries as technical implementers in the field is Coastal Fishing Port III Bajomulyo under the Maritime and Fisheries Service of Central Java Province and the Maritime and Fisheries Service of Pati Regency.	W4	The Silugonggo River channel has been optimized by local communities and entrepreneurs to open boat docks, food stalls, boat building and mooring activities. This has further exacerbated the pollution and sedimentation in the channel as the onsite monitoring function of the relevant authorities is very minimal or non-existent.
		W5	The commercial port has become quiet, commercial ship visits seem to be decreasing from year to year, so the distribution of goods other than fish is decreasing.
Code	*Opportunity*	*Code*	*Threat*
O1	Increased fish catches entering the Juwana fishing port.	T1	The occurrence of sedimentation is aggravated as the flow of the river is hindered by its smooth operation. The overhaul and construction of fishing boats with GT < 30 with field data showed that about 1000 ships create the crowd in the river channel. Vessels that do not go to sea, moor in the river channel.

O2	The volume of overhaul and construction of vessels of gross tonnage > 30 is very rapid, which has an impact on fish productivity and economic improvement.	T2	The accumulation of mooring vessels in the Silugonggo River channel and the conduct of ship repair activities with vessel dimensions is approximately 24 meters in length, 3 to 5 meters in width with a transverse mooring position, further narrowing the channel width, affecting vessel traffic in and out of the channel and impeding the smooth flow of water from upstream to downstream.
O3	The construction of the port pool in Juwana is expected to be able to accommodate approximately 300 vessels with a size of GT < 30.	T3	The malfunctioning of the Post II port and the decrease in ship arrivals at the Juwana port bause the obstruction at the Silugonggo River channel by ships mooring and anchoring and carrying out repair activities make the commercial port less optimal due to the reluctance of commercial ships to enter the Juwana port.
O4	There are services of Port Management Unit Class III Juwana and Coastal Fishing Port Bajomulyo which are very excellent and educational, providing services, handling ship arrivals and departures both commercial ships and fishing vessels, serving ship certification documents, checking the safety and security of ship arrivals and departures, fuel bunkering activities, supervision of maritime environmental protection and mooring management.	T4	There is a potential for overlapping management as the management of the Silugonggo River channel is the responsibility of BBWS Pemali Juwana, but the implementation of channel management and the collection of mooring fees are managed by the relevant agencies, namely Port Management Unit Class III Juwana, Coastal Fishing Port Bajomulyo and the Pati Regency Government.

IFAS matrix measurement based on the weight values and scores given by the respondents within the internal factors was conducted with the following results (Table 2).

Table 2

IFAS matrix calculation

No.	*Strength*	*Weight*	*Rating*	*Score*
1	S1	0.146	3	0.438
2	S2	0.138	3	0.414
3	S3	0.136	3	0.408
4	S4	0.144	3	0.432
Total strength				1.69
No.	*Weakness*	*Weight*	*Rating*	*Score*
1	W1	0.082	2	0.164
2	W2	0.088	2	0.176
3	W3	0.094	2	0.188
4	W4	0.084	2	0.168
5	W5	0.088	2	0.176
Total weakness				0.87
Total IFAS		1		2.56

The calculation on the EFAS matrix was performed based on the weight values and scores given by the respondents within the external factors. The EFAS matrix results are shown in Table 3.

Table 3

EFAS matrix calculation

No.	*Opportunity*	*Weight*	*Rating*	*Score*
1	O1	0.164	3	0.491
2	O2	0.161	3	0.484
3	O3	0.157	3	0.470
4	O4	0.161	3	0.484
Total opportunity				1.93
No.	*Threat*	*Weight*	*Rating*	*Score*
1	T1	0.086	2	0.173
2	T2	0.089	2	0.177
3	T3	0.084	2	0.168
4	T4	0.098	2	0.195
Total threat				0.71
Total EFAS		1		2.64

Calculations of factors were illustrated using a Cartesian diagram to group strategic factors that could be utilized in formulating subsequent management steps. The outcome of calculating the coordinate points was 0.41 and 0.61, placing the coordinate points at (0.69; 0.345) as shown in Figure 2.

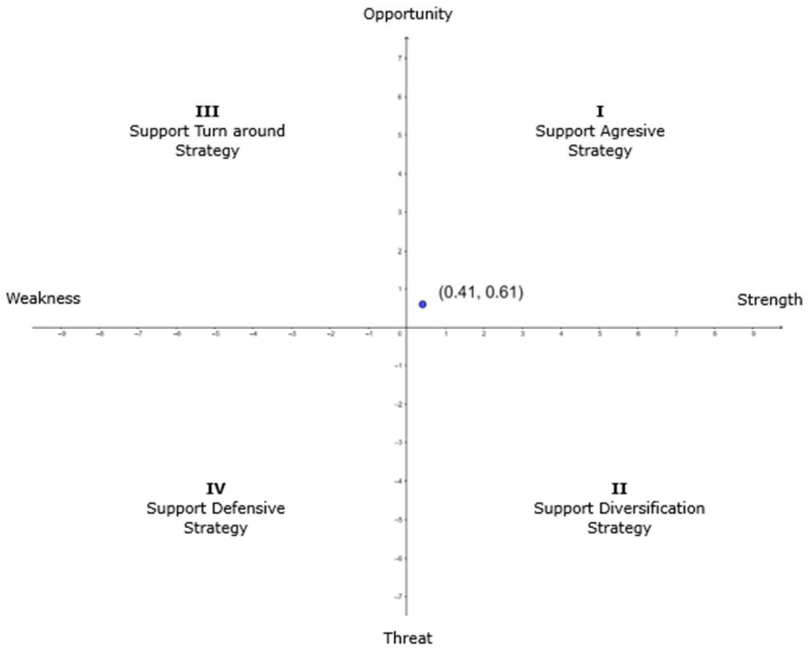

Figure 2. SWOT cartesian diagram.

Based on Figure 2, Quadrant 1 highlights the presence of both strengths and opportunities related to the Silugonggo River channel, suggesting that the area has a solid foundation upon which to build and capitalize on potential advantages. The combination of these strategies is shown in Table 4.

Table 4

SWOT matrix strategy combination

IFAS / *EFAS*	*Strength* *(S1, S2, S3, S4)*	*Weakness* *(W1, W2, W3, W4, W5)*
Opportunity (O1, O2, O3, O4)	(SO1) Developing businesses in the fisheries sector for the surrounding community because the catch of fish entering the Juwana fishing port is increasing (S1, S2, O1);	(WO1) Making policies and regulations regarding ship waste disposal and ship berthing locations to reduce sedimentation and density of the Silugonggo River channel (W1, W2, O4);
	(S02) Increasing the size of the ship's gross tonage measuring < 30 GT to make the flow channel in Juwana (S1, O1, O2);	(WO2) Creating policies and regulations regarding the location of the overhaul and construction of GT > 30 vessels to optimize the distribution of fish catches (W1, W2, O2, O4);
	(S03) Building a port pool for ships measuring < 30 GT to allow the river flows smooth since it is the only strategic channel in Juwana (S1, S3, O2, O3);	(WO3) Providing additional budgeting to accelerate the development of port pool to help improve distribution and economy in fisheries (W3, O1, O3, O4);
	(SO4) Optimizing and harmonizing the service functions of Port Management Unit Class III Juwana under the authority of the Ministry of Transportation and Coastal Fishing Port Bajomulyo under the Marine and Fisheries Service of Central Java Province and the Marine and Fisheries Service of Pati Regency in regulating the flow of the Silugonggo River. Training in the fisheries sector needs to be promoted to the community (S1, S3, S4, O3, O4);	(W04) Applying regulations regarding waste disposal carried out by communities who open fishing businesses on the border of the Silugonggo River to avoid polluting the river (W4, O4);
	(S05) Cooperation among stakeholders in managing the Silugonggo River channel. Implementing regulations to control the mooring of vessels carrying out ship repair and construction activities in the river channels, thus that vessels carrying out repair and overhaul activities must dock under the supervision of the relevant authorities. Provide sanctions for vessels that carry out activities in river channels without permission and supervision (S2, S3, S4, O4);	(WO5) Providing policies regarding the use of commercial ports so that they can be used again by the community to enhance the distribution of commodities other than fish (W4, W5, O4).
	(SO6). Making firm policies and regulations regarding the size and feasibility of fishing vessels to be used (S1, O2, O4).	

Threat (T1, T2, T3, T4)	(ST1) Creating anchorage ponds and regulate the location and safety of ship pool to parse the density of the channel so as not to inhibit the flow of the river and unravel the density of the river channel (S2, S3, S4, T2); (ST2) Prohibit ships and fishery entrepreneurs from littering and waste to prevent pollution and sedimentation around the river (S1, S4, T1); (ST3) Providing ship berthing regulations and policies to allow commercial ports can function optimally (S3, S4, T2, T3); (ST4) Optimizing the existence of two government agencies to avoid overlapping in providing the services (S4, T3, T4).	(WT1) Creating and strengthening the regulations for the disposal of ship waste and fishery entrepreneurs' waste along the channel and border of the Silugonggo River to reduce sedimentation (W1, W4, T1); (WT2) Building a port pool for berthing ships and make regulations regarding the size and specifications of ships anchored in the Silugonggo River channel (W2, W3, T2); (WT3) Applying rules for ships that to enter around commercial ports in order to optimize and re-function of the commercial ports (W2, W5, T3); (WT4) Grouping the service rules of the Ministry of Transportation with the Maritime Affairs and Fisheries Service of Central Java Province and the Marine and Fisheries Service of Pati Regency to avoid overlapping (W5, T3, T4).

The primary focus of marine protection strategies, as indicated by the Cartesian diagram, falls within Quadrant 1, where the emphasis is on leveraging the strength factors in conjunction with opportunities as shown in Table 4. After reviewing the SWOT strategy based on the quadrant and the combination of IFAS and EFAS, alternative strategies and policies were formulated. Alternative strategies were formulated based on the priority levels as presented in Table 5.

Based on the analysis, the highest priority is assigned to strategy (SO4), which focuses on maximizing and coordinating the service functions of the Port Management Unit Class III Juwana, under the Ministry of Transportation, and the Coastal Fishing Port Bajomulyo, under the jurisdiction of the Marine and Fisheries Service of Central Java Province and Marine and Fisheries Service of Pati Regency. This strategy is aimed at enhancing regulation of the Silugonggo River channel and providing community training in the fisheries sector. The second priority, strategy (S03), involves the construction of a mooring pool for vessels under 30 GT to ensure the smooth flow of the river, recognizing its critical role as the only strategic channel in Juwana. The third priority, strategy (S05), seeks to foster cooperation among stakeholders in managing the Silugonggo River channel, including implementing regulations to control the mooring and activities of vessels undergoing repair and construction in the river channels. This strategy emphasizes that such activities must only occur under the supervision of relevant authorities, with sanctions applied to vessels conducting unauthorized activities. This prioritization provides a clear framework for deciding which protection strategy to implement first.

Table 5

Alternative strategies on SWOT

No.	*SWOT combination*	*Relevant factors*	*Total score*	*Priority rating*
	SO strategy			
1	SO1	S1, S2, O1	1.343	8
2	SO2	S1, O1, O2	1.413	6
3	SO3	S1, S3, O2, O3	1.801	2
4	SO4	S1, S3, S4, O3, O4	2.233	1
5	SO5	S2, S3, S4, O4	1.738	3
6	SO6	S1, O2, O4	1.406	7
	WO strategy			
1	WO1	W1, W2, O4	0.824	13
2	WO2	W1, W2, O2, O4	1.308	9
3	WO3	W3, O1, O3, O4	1.633	4
4	WO4	W4, O4	0.652	15
5	WO5	W4, W5, O4	0.828	12
	ST strategy			
1	ST1	S2, S3, S4, T2	1.431	5
2	ST2	S1, S4, T1	1.043	11
3	ST3	S3, S4, T2, T3	1.185	10
4	ST4	S4, T3, T4	0.796	14
	WT strategy			
1	WT1	W1, W4, T1	0.505	18
2	WT2	W2, W3, T2	0.541	16
3	WT3	W2, W5, T3	0.502	19
4	WT4	W5, T3, T4	0.540	17

Discussion. Protection and management strategies have been developed to protect the marine environment in the Silugonggo River shipping lane. Marine environmental protection in the Republic of Indonesia Government Regulation No. 21 of 2010 on Maritime Environmental Protection is defiend as efforts to prevent and mitigate pollution in aquatic environments arising from shipping-related activities. The necessity for implementing coastal environmental protection measures in the Silugonggo River navigation channel is underscored by research findings, which reveal that various community activities along the river - such as ship mooring, ship repair and construction, fuel loading and unloading, passenger and crew embarkation and disembarkation, along with port operations - negatively impact the river's condition with water pollution, sedimentation and obstruction of navigation channels (Arvianto et al 2016; Aina et al 2016). Likewise, Aspiany et al (2019) explained that most of the problems related to the degradation of natural resources due to human activities exceeding the carrying capacity of the environment.

The quality of fishery products is significantly influenced by the condition of the fish market at fishing ports, where cleanliness and comprehensive infrastructure play pivotal roles in enhancing product quality (Hasani et al 2020; Prasetiawan 2023). However, a challenge to this improvement is the lack of pollution prevention equipment on most fishing vessels, as specified by the Republic of Indonesia Government Regulation No. 21 of 2010 on Maritime Environmental Protection including: a. For vessels with a GT size of 100 (one hundred gross tonnage) or more and/or a main propulsion engine size of 200 HP (two hundred horsepower) or more, they must have at least oil pollution prevention equipment which includes: (1) an oily water separator; (2) a sludge tank; and (3) a standard discharge connection (Republic of Indonesia Government Regulation, No. 21 of 2010 on Maritime Environmental Protection). Ships with 15 (fifteen) or more sailors must have equipment to prevent pollution by sewage, including (1) a sewage treatment plant; (2) a sludge crusher; and/or (3) a holding tank and a standard discharge connection. Each vessel shall have at least one device to prevent pollution by garbage, which shall include (1) garbage holding tanks; and (2) marking.

These strengths and opportunities underscore its potential for development into a robust coastal environmental protection strategy. This strategy is aimed at regulating the flow of the Silugonggo River and providing community training in fisheries. The critical role of related agencies in fostering fisheries activities is underscored by Alfiana et al (2018), who noted that fishing ports serve as public institutions with the primary objective of delivering optimal service to satisfy the needs of the fishing community, especially fishermen. Fishermen are recognized as a key driving force in the fishing industry, indicating the necessity of supportive policies and frameworks to enhance their operations and, by extension, contribute to the broader goals of coastal environmental protection and sustainable fisheries management.

Based on the results of the SWOT analysis, the management of coastal environmental protection strategies in the Silugonggo River channel (Pati Regency) and the alternative strategies have been proposed. The results also highlight the need for optimization and synchronization of service functions between the Port Management Unit Class III Juwana, under the Ministry of Transportation, and the Coastal Fishing Port Bajomulyo, managed by the Maritime and Fisheries Service of Central Java Province and the Maritime and Fisheries Service of Pati Regency. Other relevant parties also need to make positive contribution as proposed by Alfiana et al (2018), that fishing ports, as public institutions need to provide the best service to meet the interests of the fishing community, especially fishermen.

The Silugonggo River channel hosts both commercial and fishing ports, with the commercial ports falling under the jurisdiction of the Ministry of Transportation, specifically managed by Port Management Unit Class III Juwana which oversees two piers, Post 1 and Post 2. The fishing ports are under the purview of the Ministry of Maritime Affairs and Fisheries, with Coastal Fishing Port III Bajomulyo being managed by the Maritime and Fisheries Service of Central Java Province and the Maritime and Fisheries Service of Pati Regency. Based on the research results, the two ministries with authority over the Silugonggo River channel are still unable to disaggregate the density of the river channel, and there is potential for overlap in the implementation of regulations. The Ministry of Transportation and the Maritime and Fisheries Agency of Central Java Province and the Maritime and Fisheries Agency of Pati Regency, as the authorities regulating the Silugonggo River channel, need to collaborate in formulating on-point regulations and policies to avoid overlapping.

Education and outreach to the community and fishermen are also very necessary to develop community's awareness about the seaworthiness of vessels and water quality. Wijayanto et al (2021) argued that fishing ports should be developed to support the fishing industry and artisanal fishing, given their pivotal role in the fishing economy. They emphasized that the management of fish auctions for traditional fishermen should be assumed by the government, reasoning that private entities or cooperatives managing these auctions are not as beneficial.

The second priority for implementation is the construction of a mooring pool for ships under 30 GT, as gross tonnage is a crucial factor in modeling ship emissions (Schwarzkopf et al 2021). Gross tonnage represents the volume of all ship's enclosed spaces from the hull to deck areas used for cargo, storage, fuel, passengers, and crew (Kurniawan & Soejitno 2018). The increasing trend of vessels with gross tonnage of more than 30 GT requires adequate mooring space outside Silugonggo River channel. The docking of vessel with approximately 24 meters long and 3-5 meters wide whether transversely or parallelly, does not only narrow the channel but also exacerbates its shallowness. The flow of the Silugonggo River is a source of sediment built up from moored ships, causing siltation in shipping lanes and disruption to the shipping traffic during low tide. The construction of a dealer pool is urgent to reduce alleviate the congestion of vessels moored in the river channel. The construction of the mooring basin is expected to address these problems.

The third priority that can be implemented is to establish cooperation among stakeholders in the management of the Silugonggo River channel. Establishing a synergistic partnership between the local community, government bodies, private sector entities, NGOs, and stakeholders involved in land use at Tapak Tugurejo Semarang is

essential. This collaboration is particularly important in adapting to land use changes to improve the management of Semarang's coastal environment, as highlighted by Irsadi et al (2017). Abdullah et al (2014) emphasize the significance of community-based conservation in mangrove management. Regulations should be enforced in the management of mooring vessels and construction activities in the river channels. Vessels that are being repaired and overhaul must be required to be supervised by relevant authorities during their docking, followed by strict penalties for any vessel that does not comply. Furthermore, the seaworthiness of the ship as stipulated in the Regulation of the Minister of Transportation of the Republic of Indonesia No. 54 of 2021 on Ratification of Ship Design Drawings, Implementation and Supervision of Ship Construction and Work should be taken into account to guarantee the safety of fishermen and to reduce environmental pollution.

Conclusions. The results of this research show that coastal management and protection strategy are priority strategies that should be implemented in Silugonggo River channel. Optimizing and aligning the service functions of Port Management Unit Class III Juwana and Coastal Fishing Port Bajomulyo will establish dealer pool with a capacity of 300 vessels under 30 GT and enhance the cooperation among stakeholders in managing the Silugonggo River channel. Regulations need to be determined to control the mooring of vessels being repaired and other construction activities in the river channels. Therefore, vessels undergoing repair and overhaul activities must dock under the supervision of the relevant authorities. Sanctions need to be imposed for vessels that carry out activities in river channels without permission and supervision.

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Conflict of interest. The authors declare that there is no conflict of interest.

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