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TECHNICAL CHARACTERIZATION OF PURSE SEINE COMPONENTS IN PEKALONGAN FISHING PORT, CENTRAL JAVA

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ABSTRACT

This study characterizes the technical specifications and operational variability of large pelagic purse seine components used at the Archipelago Fishing Port (PPN) Pekalongan, Central Java. Eight purse seine units were analyzed through direct measurement, observation, and in-depth interviews. Results indicate that nets are constructed from polyamide (PA) with mesh sizes ranging from 2 inches (50.8 mm) in the bunt to 4 inches (101.6 mm) in the wings and body, and denier sizes from d12 to d30, corresponding to sinking forces of 2.69–8.14 kgf per 100 m. All ropes are polyethylene (PE) with diameters from 10–60 mm, with the ground rope consistently 10% longer than the head rope. Two float types were used: DS2 (1.163 kgf buoyancy) on wings/body and YQE-20 (1.760 kgf) on the bunt, contributing total buoyancy between 2,868.68–3,530.19 kgf. Sinkers were made of lead, with two weight classes (0.211 kg and 0.243 kg), and total sinking forces ranged from 1,008.35–1,327.66 kgf. Rings were stainless steel, providing additional sinking force of 0.366–0.537 kgf each. Significant inter-vessel variations were observed in component dimensions and quantities, reflecting adaptive, experience-based designs. The findings provide a technical baseline for optimizing gear efficiency, improving catch performance, and supporting sustainable purse seine fisheries management in Indonesian waters.

KEYWORDS: buoyancy, component specification, gear efficiency, sinking force

INTRODUCTION

Capture fisheries activities are an important economic sector in Indonesia, as they make a significant contribution to food security (Roberts et al, 2023), provide jobs for many people

(Sari et al., 2021; Stacey et al, 2023), and generate foreign exchange for the country (Octavia et al, 2024). The northern coastal area of Java Island, including Central Java, is a dynamic fisheries hub (Susilo et al, 2025). One of the largest fishing ports in this region is the Archipelago Fishing Port (PPN) of Pekalongan. One of the dominant fishing gear types at PPN Pekalongan is the purse seine. A purse seine is an encircling net designed to catch shoaling fishes (Pravin & Meenakumari, 2016).

Based on the Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 36 of 2023, purse seines are classified into several types: small pelagic purse seines with a single vessel, large pelagic purse seines with a single vessel, anchovy purse seines with a single vessel, small pelagic purse seines within a fleet unit, large pelagic purse seines within a fleet unit, small pelagic purse seines with two vessels, and encircling nets without purse lines. Large pelagic purse seines target catches such as tuna, skipjack, and mackerel. The effectiveness and efficiency of purse seines depend on various components, including the type and size of the net (Ririmasse et al, 2021), configuration of floats and sinkers (Liu et al, 2020), and specifications of the ropes used.

The characteristics of each purse seine component play a crucial role in the performance of the fishing gear. The mesh size determines sinking performance, whereas the balance between floats and sinkers determines the net's ability to close and catch the fish. There are various fishing vessels at PPN Pekalongan that use large pelagic purse seines, but detailed information about the specific characteristics of the gear components they use remains limited. A thorough understanding of the actual configuration of these components is essential to analyze optimization potential, identify operational constraints, and develop relevant policies for sustainable fisheries management in the area. Without an in-depth study of the actual components used, efforts to improve the efficiency and sustainability of purse seine operations at PPN Pekalongan will be less well directed. This study aimed to describe the characteristics of the components of large pelagic purse seines and identify variations in the characteristics of large pelagic purse seine components among fishing fleets based at PPN Pekalongan.

METHODOLOGY

Time and Location of Research

This study was conducted from October to November 2024. The study location was the Archipelago Fishing Port (PPN) Pekalongan, Central Java. PPN Pekalongan was chosen as the study site because it is one of the largest fisheries ports in Central Java and serves as a main base for the fleet of large pelagic purse seine fishing vessels. Data collection was conducted directly in the port area. The number of large pelagic purse seine samples used in this study was eight

Data Collection Method

This study used a quantitative descriptive method with a case study approach. Primary data were collected using several techniques.

- Direct Observation: Observations were carried out on large pelagic purse seine fishing vessels docked at PPN Pekalongan, Indonesia. The observations focused on the visual identification of purse seine components.
- Component Measurement: Accessible components of the purse seine were measured directly using measuring tools (tape measure, caliper, and scale). Measurements included the dimensions of the net (length, height, and mesh size), diameter and length of ropes, size and number of floats, and size and weight of sinkers.
- In-depth interviews were conducted with relevant key informants, such as ship captains, ship owners, and purse seine craftsmen. The interviews aimed to gather information about the technical specifications of the components, materials used, reasons for selecting certain components, and operational challenges faced in relation to the fishing gear.

Data Analysis

The collected data were analyzed using descriptive quantitative methods. Quantitative data obtained from the measurement of components (dimensions, weight, quantity) are presented in the form of tables, graphs, and descriptive statistics (average, standard deviation, range). Qualitative data from interviews and document studies were analyzed using interpretative methods to understand the context, meaning, and implications of the component characteristics found. The characteristics of the ship fleets were compared to identify existing variations and patterns. This analysis aims to answer the research questions regarding component characterization and the variations present in PPN Pekalongan.

- Calculating the weight and identifying the size and thread number of PA and PE nets in purse seine fishing gear. According to Prado and Dremiere (1991), the weight of a knotted seine net was calculated using the following formula:

$$W = H \text{ x } L \text{ x } \frac{Rtex}{1000} \text{ x } K = H \text{ x } L \text{ x } \frac{1000}{m/kg} \text{ x } K$$

Information:

W = net weight (kg).

H = number of vertical nodes in the net

L = length of the net when stretched (m);

Rtex and m/kg = net thread size

K = node correction factor according to the node weight.

- Calculating the weight and identifying the material of each size and type of rope used in purse seine fishing gear. According to the National Standardization Agency (2016), the method for measuring rope can be calculated using the following formula:

V = A x L x k

W = V x ρ x g

Information:

V = volume (m^3).

A = cross-sectional area (m^2).

L = length of the rope (m).

k = volume coefficient PE (0,62 – 0,65);

W = rope weight (kg).

ρ = density of the material (kg/m3);

g = gravitational acceleration (m/s^2).

RESULT AND DISCUSSION

General Description of Purse Seine Nets Used at PPN Pekalongan

Based on statistical report data from PPN Pekalongan (Figure 1), there were fluctuations in the number of each type of fishing gear from 2019 to 2023. The dominant fishing gear were large pelagic purse seines and small pelagic purse seines, with a total of 130 and 76 units, respectively, in 2023. Other types of fishing gear fall into the category of those operated in small numbers, usually by individual fishers or small groups of fishers. The fishing gear included in this category are hand lines, longlines, squid jigs, and cast nets.

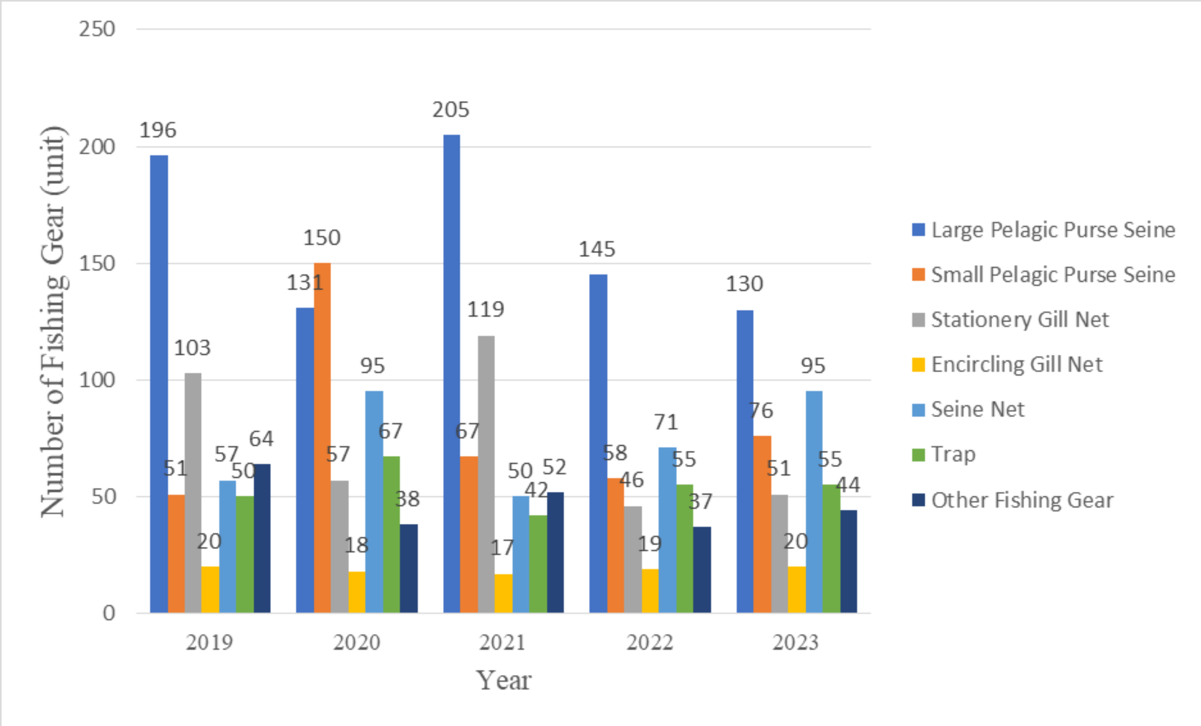

Figure 1. Number of Fishing Gear in PPN Pekalongan.

Source: PPN Pekalongan (2024)

Net Structure and Material Specifications

A purse seine is a rectangular net consisting of wings, a body, equipped with floats, weights, a head rope, a ground rope, with or without a purse line, and one part of the net functions as a bunt (Hutapea et al., 2021). Purse seines were divided into three functional sections: wing (PA d12, 4-inch mesh), body (PA d15-d18, 4 inch mesh), and bunt (PA d27-d30, 2 inch mesh). The wings function to obstruct the school of fish, directing them towards the net body, which will then guide them into the bunt section (Katiandagho & Korwa, 2023; Sofijanto et al., 2025). The body functions as a large strip-type structure, typically made of various netting panels, for the effective capture of pelagic species (Zhou et al., 2015a). The bunt is the part of the net that serves as a false pocket, where the fish concentrate after the purse line is pulled (Laissanne, 2011; Isman et al., 2018).

The bunt of the large pelagic purse seine in PPN Pekalongan is located at the center of the net body. The mesh size used was 2 inches (50.8 mm) in the bunt section and 4 inches in the wings and body. This is in accordance with PERMEN KP 36/2023, which states that large pelagic purse seines use a mesh size of greater than or equal to 2 inches. This is similar to tuna purse seine vessels operating in the Eastern Indian Ocean, which use 105-mm mesh in the wings and 90-mm mesh in the bunt (Chumchuen et al., 2016), and Chinese tuna purse seine vessels targeting skipjack tuna, where the mesh size ranges from 90 mm (the bunt) to 260 mm (main body) (Tang et al., 2017).

The sinking force increased with denier size, from 2.69 kgf (PA d12) to 8.14 kgf (PA d30) per 100 m length (Table 1). The bunt section uses thicker yarns (higher denier) because it requires a stronger material and a higher breaking strength than other sections (Katiandagho & Korwa, 2023). Thicker yarns (higher denier) can also enhance the sinking performance of the net due to greater drag (Hosseini et al., 2011; Zhou et al., 2015b; Shan et al., 2023). Higher denier yarns typically have higher tensile strength, which can contribute to the overall sinking force by maintaining the structural integrity of the net during the sinking process (Zhou et al, 2015b; Shan et al, 2023)

Table 1. Net material specifications and sinking force.

Material	Mesh Size (mm)	Sinking Force (kgf/100 m)
PA d12	101.6	2.69
PA d15	101.6	3.41
PA d18	101.6	4.12
PA d27	50.8	7.23
PA d30	50.8	8.14

Rope system

All ropes installed in large pelagic purse seines use polyethylene (PE). The diameter and length of each rope were as follows: head rope (10-12 mm; 875-1150 m), ground rope (12-14 mm; 1050-1265 m), and purse line (56-60 mm; 1312.5-1725 m). The ground rope was consistently approximately 10% longer than the head rope, ensuring vertical alignment. This is similar to anchovy purse seines in North Coastal Java, which have a ratio of approximately 0.926 and 0.991, indicating that the net is almost trapezoidal (Sasmita et al., 2024). The diameter of the ropes used is also similar to that in Vietnamese purse seine fisheries, including the float line (head rope) and lead line (ground rope), mainly in the range of 10-20 mm (Hung et al., 2021).

Polyethylene (PE) is commonly used in rope systems for large pelagic purse seine fishing because of its durability and resistance, low water absorption, and hydrodynamic properties. PE has a very low water absorption, which means that the ropes remain lightweight even when wet. The lightweight nature of PE ropes reduces the physical strain on fishermen and improves the efficiency of net setting and hauling. This can lead to better catch rates and reduced operational costs (Rizwan et al., 2014). PE ropes have favorable hydrodynamic properties, such as lower drag coefficients, which enhance the performance of fishing gear in water. This can improve the net's sinking speed and overall effectiveness in capturing fish (Huang et al., 2014).

Float and Sinker Systems

1. Float specifications and buoyancy contribution

Two types of floats were identified, both oval-shaped but differing in size, weight, and buoyancy capacity (Table 2).The DS2 float is primarily used on the wing and body sections of the net to provide stability and maintain the net’s position at the water’s surface. The YQE-20 float, with approximately 51% higher buoyancy than the DS2, was deployed exclusively in the bunt section. Float distribution varied significantly across vessels (Table 3), with total float counts ranging from 2,442 to 2,906 units. The floats on the bunt represented only 7–9% of the total floats but contributed 12–15% of the total buoyancy owing to the use of YQE-20 models. This asymmetric design aligns with the need for enhanced flotation in the central trapping zone of the net.

Overall, the total buoyancy generated by these floats per net ranged from 2,868.68 to 3,530.19 kgf, indicating the floats’ ability to withstand the weight and water pressure acting on the net. The bunt section of the purse seine experiences higher tension forces than other parts of the net during fishing operations. This is due to the concentration of fish and the forces exerted when the net is closed or pursed (Zhou et al., 2015a; Zhou et al., 2019). More floats and greater buoyancy help counteract the influence of ocean currents, which can cause net deformation. With greater buoyancy, the nets can maintain their shape, even when exposed to strong currents (Zhou et al., 2015b; Zhou et al., 2019; Liu et al., 2020).

There are two types of floats used on large pelagic purse seine fishing gear at PPN Pekalongan: DS2 and YQE-20 floats. The YQE-20 float is yellow and is used on the bunt section because it has a higher buoyancy, whereas the DS2 float is white and is used on the wings and body sections. The following are the size, distance, and number of floats on each large pelagic purse seine can be seen in Table 4.

Table 3. Specifications of Large Pelagic Purse Seine Floats.

Type	Shape	Size (mm)			Weight (kg)	Bouyancy (kgf)
		L	$Ø_o$	$Ø_i$		
DS2	Oval	170	115	22	0.130	1.163
YQE-20	Oval	177	135	30	0.272	1.760

Table 4. Specifications of large pelagic purse seine floats.

Vessel Name	Head Rope (m)	Number of Floats (buah)				Bouyancy(kgf)
		Wing	Body	Bunt		
PS 1	1100	1371	1011	240		3192.73
PS 2	975	1164	1284	285		2868.68
PS 3	1150	1097	1280	272		3243.24
PS 4	950	1102	1280	224		3164.56
PS 5	1050	1209	1368	248		3433.59
PS 6	1075	1227	1427	252		3530.19
PS 7	875	970	1247	232		2986.75
PS 8	1070	1174	1228	252		3237.11

2. Sinker specifications and sinking capacity

The sinkers used in large pelagic purse seines are all constructed from lead (Pb) and vary in weight, and are categorized primarily based on their positioning along the ground rope. Lead is the most commonly used material in purse seine fishing gear because of its effectiveness in providing the weight needed to ensure that the net sinks properly (Shan et al., 2023; Maya et al., 2024). These sinkers serve a critical function by acting as counterweights, ensuring that the net maintains its intended depth and does not float excessively or rise to the surface during fishing operations. The proper use of weights can improve operational efficiency by ensuring that the net reaches the desired depth more quickly, thereby enabling more effective fishing (Rizwan et al., 2014; Shan et al., 2023).

Two types of lead sinkers were used across all observed purse seines, differing in their dimensions and weights (Table 4). The larger sinker (58 mm length, 31 mm outer diameter) had a weight of 0.243 kg and a sinking force of 0.221 kgf, whereas the smaller sinker (55 mm length, 28 mm Ø) weighed 0.211 kg with a sinking force of 0.192 kgf. The consistent use of lead reflects its high density (≈11,340 kg/m³), which provides a substantial sinking force with a relatively compact size. The distribution of sinkers varied significantly across net sections and vessels (Table 5). The body section consistently contained the highest number of sinkers (ranging from 2,107 to 3,040 units), followed by the wings (1,943–3,080 units) and the bunt (320–493 units). A large number of sinkers on the body and wings of the purse seine is needed for effective fishing, because initial sinking speed is critical for encircling the fish school before closing the bottom (Zhou et al., 2015b)

Table 4. Specifications of sinkers used in large pelagic purse seines.

Material	Size (mm)			Weight (kg)	Sinking Force (kgf)
	L	$Ø_l$	$Ø_d$		
Lead (Pb)	55	28	13	0,211	0,192
Lead (Pb)	58	31	15	0,243	0,221

Table 5. Sinker and sinking force distribution across vessels.

Vessel Name	Ground rope (m)	Number of Sinker			Weight (kg)	Singking Force (kgf)
		Wing	Body	Bunt		
PS 1	1210	2528	3000	475	1458,97	1327,66
PS 2	1092	1943	2296	320	1108,08	1008,35
PS 3	1265	2496	3040	493	1272,33	1157,82
PS 4	1140	2336	2800	447	1356,91	1234,79
PS 5	1260	3080	2286	493	1236,46	1125,18
PS 6	1236	3040	2107	456	1361,77	1239,21
PS 7	1050	2123	2364	344	1174,18	1068,50
PS 8	1231	2080	2609	480	1256,31	1143,24

3. Ring

All rings observed in the purse seines were made of stainless steel and circular in shape, with two size variations (Table 6). The larger ring (outer diameter Øl = 140 mm, inner diameter Ød = 78 mm) weighed 0.618 kg and provided a sinking force of 0.537 kgf. The smaller ring (Øl = 120 mm, Ød = 72 mm) weighed 0.422 kg and had a sinking force of 0.366 kgf. The use of stainless steel ensures corrosion resistance, high tensile strength, and durability in marine environments, which is critical given the repeated mechanical stress experienced during net hauling.

The ring numbers varied considerably across the eight sampled vessels, ranging from 641 rings (PS 7) to 1,080 rings (PS 8), as shown in Table 7. A moderate positive correlation ($R^2 \approx 0.72$) was observed between the ground rope length and number of rings, indicating that longer nets generally incorporate more rings to distribute the pursing tension evenly. For instance, PS 3 (ground rope 1265 m) used 959 rings, whereas PS 7 (1050 m) used only 641 rings. Table 6. Specification of Ring.

Table 6. Specifications of rings used in large pelagic purse seines.

Material	Shape	Size (mm)		Weight (kg)	Sinking force (kgf)
		$Ø_l$	$Ø_d$		
Stainless Steel	Circle	120	72	0.422	0.366
Stainless Steel	Circle	140	78	0.618	0.537

Table 7. Ring and sinking force distribution across vessels.

Vessel Name	Ground rope (m)	Number of ring	Weight (kg)	Singking Force (kgf)
PS 1	1210	739	1458.97	1327.66
PS 2	1092	667	1108.08	1008.35
PS 3	1265	959	1272.33	1157.82
PS 4	1140	865	1356.91	1234.79
PS 5	1260	876	1236.46	1125.18
PS 6	1236	711	1361.77	1239.21
PS 7	1050	641	1174.18	1068.50
PS 8	1231	1080	1256.31	1143.24

Comparison with standards performance

In general, the characteristics of the purse seine components reported from PPN Pekalongan are in line with internationally recognized design principles for purse seine gear targeting large pelagic fish. For example, the ratio between net length, net height, and mesh size was designed to achieve optimal catch efficiency. The ratio of net depth to expected fishing depth and the balance between the buoyancy of the floats and weight of the sinkers are key factors that influence the net's ability to effectively capture schools of fish.

Variations in component specifications between vessels can be interpreted as forms of adaptation based on the fishermen's operational experience and local knowledge. The use of heavier sinkers is a response to certain water conditions in fishing areas with stronger currents or greater water depths. Similarly, choosing different net lengths may reflect different fishing strategies, whether in terms of the target school size or frequency of operations.

CONCLUSION

The characterization of large pelagic purse seine components at PPN Pekalongan reveals a functionally segmented and materially specialized fishing gear system, designed to target species such as tuna, skipjack, and mackerel. The net structure is divided into wings, body, and bunt, each with distinct mesh sizes and yarn densities to balance fish herding, retention, and capture. The consistent use of polyethylene (PE) ropes and polyamide (PA) nets reflects a balance between durability, buoyancy, and hydrodynamic performance. The float and sinker systems are strategically configured, with higher buoyancy concentrated in the bunt and greater sinking force distributed across the wings and body to facilitate effective net closure. Stainless steel rings further contribute to sinking dynamics and pursing functionality.

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