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Comparative Assessment of Maintenance Requirements and Perceived Economic Feasibility of HDPE, Fibreglass and Inflatable Boats

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ABSTRACT

High-density polyethylene (HDPE), fibreglass-reinforced polymer and inflatable construction each offer different procurement, operating and maintenance characteristics for small boats. This descriptive comparative study examined the perceived maintenance practicality and economic considerations of these three hull types using a four-point questionnaire administered to 12 maritime practitioners, alongside a review of marine materials and boatbuilding literature. Respondents included maintenance personnel (50.0%), manufacturers (33.3%), a marine drafter (8.3%) and another maritime practitioner (8.3%). The reported item-level ratings were organised into repair complexity, cleaning requirements and service intervals. Unadjusted averages for HDPE, inflatable and fibreglass boats, respectively, were 3.80, 2.50 and 3.00 for repair items; 3.90, 2.90 and 2.60 for cleaning; and 3.50, 2.90 and 3.00 for servicing. These descriptive averages reproduce the available item summaries but contain positively and negatively phrased statements. Because individual response records and documented polarity rules were unavailable, the averages cannot be accepted as validated comparative maintenance-performance scores. An explicit polarity-adjusted sensitivity calculation reveals that the interpretation of repair complexity may change when negative items are reversed. The evidence suggests potential practical advantages of HDPE for particular small-craft applications but does not establish monetary lifecycle savings or universal technical superiority. The study identifies priorities for consistent repair training, material-specific maintenance protocols, comparable cost records and more robust vessel-level evaluation.

Keywords: high-density polyethylene; small-boat construction; inflatable boats; comparative survey; lifecycle cost

1. Introduction

1.1 Research background

Material selection for small boats influences hull fabrication, impact tolerance, repairability, cleaning, servicing and end-of-life management (Gölpınar, 2005; Nisazarifa et al., 2026). Fibreglass-reinforced polymer (FRP) and inflatable constructions are familiar choices in recreation, utility transport, coastal work and safety services; HDPE has received growing attention as an alternative because it is thermoplastic, weldable and resistant to seawater corrosion (Bertagna et al., 2025; Watt et al., 2021). Material performance nonetheless depends on hull design, stabilisation additives, reinforcement, fabrication quality and service conditions, so an alternative that performs well in one vessel class need not perform equally well in another (Firmanda et al., 2022; Lee et al., 2017; Veritas, 2022).

The technical literature has demonstrated several promising applications. Ridwan et al. (2022) investigated welded laminates of recovered HDPE drums in small-boat construction; Brawijaya et al. (2021) analysed HDPE boat stability and structure; and Telak et al. (2023) evaluated operational capabilities of an HDPE rigid-inflatable-boat-type craft. These investigations offer useful support for considering HDPE, but none alone provides a complete comparison of purchasing, servicing, downtime and actual through-life costs for equivalent boats (Amiruddin et al., 2014; Hrabenko & Kuznetsov, 2021). Sustainable material selection also demands a broader lifecycle view than simple recyclability: collection, production, service life and disposal conditions matter (Pommier et al., 2015).

1.2 Problem statement

Boat owners may face difficult trade-offs between purchase price, local availability, damage tolerance, labour-intensive repairs and downtime (Dorland & Jørgensen, 2025; Norgren et al., 2020). The long-standing use of fibreglass and inflatable boats does not remove their maintenance needs, while the claimed durability of HDPE does not by itself demonstrate that ownership will be less expensive (Bertagna et al., 2025; Wibawa & Birmingham, 2018). A meaningful comparison must separate three types of evidence: established material properties, stakeholders' perceptions of maintainability, and recorded financial or operational outcomes (Ehlen, 1997; Ilg et al., 2015). The present study addresses the first two categories but does not contain the vessel-matched cost records required for a definitive economic assessment.

1.3 Research questions and objectives

The study addresses three related questions: (1) how HDPE, fibreglass and inflatable construction compare in terms of perceived economic and maintenance considerations; (2) how the perceived repair process, cleaning needs and service intervals differ; and (3) what recommendations may improve material selection and maintenance practices for particular operational contexts. Accordingly, its objectives are to identify economic and maintenance considerations, compare the reported maintenance-indicator ratings and develop recommendations for manufacturers, owners, practitioners and policymakers.

1.4 Scope and significance

The comparison concerns the three stated types of small-craft construction and the views of 12 practitioners with relevant maritime roles. It includes qualitative purchasing and operating factors, responses to 30 maintenance statements, and a literature-based discussion of materials engineering. The sample is too small and not demonstrably representative of the broader boat-owning population; results therefore describe this group rather than population-wide preferences. The contribution lies in a transparent account of the questionnaire evidence and in identifying the next measurements needed to establish lifecycle cost and technical fitness for purpose.

2. Literature Review

2.1 Material properties and structural considerations

HDPE is a thermoplastic that can be processed and joined through appropriate heating and welding techniques (Alhatti et al., 2025; Bosseler et al., 2023). Unlike metallic hulls, the polymer does not undergo electrochemical corrosion of the base material, although attached fittings, fasteners and machinery may still corrode (Chen et al., 2016; Wibawa et al., 2023). Its mechanical response is affected by temperature, long-term load and joining quality (Frej et al., 2021). By contrast, FRP hulls use fibres and a polymer matrix, for which laminate workmanship and damage modes such as cracking and delamination are important (Vizentin & Vukelić, 2020). Inflatable constructions rely on flexible fabrics, attachment details, seams and inflation systems; such distinctions make direct material-to-material claims inadequate without controlling the vessel configuration (Said, 1999).

Veritas (2022) provides structural calculation and survey requirements specifically addressing HDPE boat structures. Its provisions reinforce the need to demonstrate hull scantlings and material properties rather than inferring structural safety from polymer type alone. Lee et al. (2017) investigated polyethylene boat structural safety through drop testing, providing a vessel-specific illustration of impact assessment. More recent work on reinforced HDPE also shows that material formulation and process affect characteristics, although its findings cannot be transferred directly to unreinforced hull sheets (Sözen & Neşer, 2024).

2.2 Recycled HDPE blue-drum construction

Ridwan et al. (2022) investigated recovered blue-drum HDPE as a construction material for a small jukung/cadik-type fishing boat. The study used welded double-layer laminates and tensile and compression testing to assess whether the resulting material satisfied the estimated loading requirement (Bertagna et al., 2024). The reported tensile result for the welded test specimen was 17.1 MPa and average compression results for relevant laminate specimens were 23.36 MPa. This is valuable evidence of construction feasibility in the defined configuration, but it is

not a general durability or maintenance-cost estimate for commercially fabricated HDPE vessels. The use of recovered drums also entails variability in feedstock history, welding quality and the suitability of the recovered material for structural service.

2.3 Stability and design of HDPE fishing and tourism boats

Brawijaya et al. (2021) developed and examined an HDPE boat design for fishing and tourism operations, assessing intact stability under three loading conditions and considering relevant structural construction criteria. The study reported that the loading conditions it examined satisfied the stability criteria applied (Brawijaya et al., 2021; Purwoko et al., 2024). This reinforces the feasibility of assessing HDPE craft through established naval-architecture procedures. Stability, however, arises from vessel geometry, loading and weight distribution as well as construction material; the study should not be read as establishing that all HDPE boats possess superior stability or incur lower maintenance costs.

2.4 HDPE motor boats with rigid-inflatable-type configurations

Telak et al. (2023) examined an HDPE-hulled motor boat with a configuration similar to a rigid inflatable boat, with field-oriented attention to operational use, equipment and rescue applications. Their work is relevant to environments requiring resilient small craft, including patrol and water-rescue tasks, while also illustrating that hull design and mission equipment require practical evaluation. The evidence supports HDPE as a candidate for those missions but does not establish broad superiority over every fibreglass or inflatable alternative, especially when equipment, payload, sea state and propulsion differ.

2.5 Recycled plastic boards and construction economics

Supomo et al. (2024) assessed recycled plastic waste boards as a hull-shell material for a four-gross-tonnage fishing vessel. The tested boards were produced from mixed plastic waste, not necessarily HDPE alone. The study reported tensile strength of 9.4 MPa and flexural strength of 17.22 MPa, and estimated hull-shell construction cost reductions of 57.79% relative to wood and 17.09% relative to fibreglass-reinforced plastic for the specific configuration. Those reported percentages belong to a distinct material, cost model and vessel design. They provide evidence that some recycled-plastic approaches may be economically competitive, but cannot legitimately be assigned to the HDPE boats surveyed here.

2.6 Finite-element assessment of HDPE small craft

Firmanda et al. (2022) used finite-element calculations and rule-gap analysis to assess HDPE as a small-vessel structural material. The reported model produced stresses of approximately 15 MPa in transverse members and 8 MPa longitudinally under defined loading cases, while also documenting sensitivity to thermal conditions (Mahl et al., 2019). These results suggest potential technical feasibility under the studied assumptions and emphasise the need for appropriate design checks. They cannot replace prototype testing, welding inspection or local operational validation. Together with the research of (Lee et al., 2017; Ridwan et al., 2022), the work supports material-specific rather than material-name-based evaluation.

2.7 Qualitative comparison of purchasing, operating and maintenance factors

The study considered purchasing, operational and maintenance factors in parallel to the detailed survey. The following three matrices preserve the qualitative expectations examined in the comparative framework. They are indicative material-selection considerations, not measurements from matched vessels or prices obtained during the survey.

Table 1. Indicative purchasing factors considered in comparing hull-construction types.

Factor	HDPE	Fibreglass	Inflatable
Initial cost	Moderate to high	Moderate	Low to moderate
Availability	Less common; fewer manufacturers	Widely available	Widely available
Customisation	High; custom builds common	High; mould-based design options	Limited; often pre-designed
Lead time	Often longer for custom orders	Shorter with mass production	Often shortest for stock designs
Weight-to-size ratio	Often heavier in comparable small craft	Moderate	Often lightest

Table 2. Indicative operational factors considered in comparing hull-construction types.

Factor	HDPE	Fibreglass	Inflatable
Durability	High potential for tolerance to impact and chemicals	May crack under impact	Puncture susceptibility
Speed and handling	Configuration and weight dependent	Potential for efficient shapes	Tube and rigidity dependent
Payload	Potentially high	Moderate to high	Tube buoyancy and vessel-dependent
Stability	Highly dependent on hull form	Highly dependent on hull form	Often high initial stability for RIBs
Weather resistance	Material grade and UV additives important	Gelcoat ageing possible	Fabric and seam grade important
Fuel efficiency	Hull shape and weight dependent	Hull form dependent	Lightweight designs may benefit
Noise and vibration	Polymer may damp vibration	Laminate response varies	Soft components may damp sound

Table 3. Indicative maintenance considerations evaluated for the three construction types.

Factor	HDPE	Fibreglass	Inflatable
Repair complexity	Plastic welding and trained personnel	Laminate preparation and curing	Fabric patching or seam repair
Cleaning	Routine cleaning; surface sensitivity varies	Cleaning and gelcoat care	Fabric cleaning, mildew checks
UV exposure	Depends on stabilisation grade	Gelcoat can weather	Fabric can degrade
Corrosion	Polymer itself non-corroding	Resin composite non-corroding	Fabric non-corroding; fittings still relevant
Storage	Rigid hull requires space	Rigid hull requires space	Some types can deflate
Service intervals	Condition and usage dependent	Regular inspections	Pressure, seam and fabric inspection
Service life	Long use possible with suitable design	Long use possible with suitable upkeep	Varies by fabric and use

2.8 Synthesis and research gap

Across this evidence base, structural capability and lower repair frequency are plausible mechanisms through which HDPE might reduce through-life burden in particular small-craft missions. However, the sources vary substantially in polymer feedstock, testing method, boat class and economic boundary. Material recyclability is not a substitute for measured lifecycle environmental performance (Pommier et al., 2015), and the cost findings from mixed recycled boards cannot be treated as HDPE fleet outcomes (Supomo et al., 2024). The present survey contributes a preliminary practitioner perspective on repair, cleaning and servicing factors, with particular attention to how the direction of questionnaire wording affects the comparison.

3. Methodology

3.1 Research design and framework

A descriptive, cross-sectional questionnaire design supported by documentary review was used. The research process was organised around identifying the practical problem, specifying objectives, selecting respondents, collecting questionnaire responses, calculating descriptive indicators, interpreting material comparisons and developing recommendations. The framework is presented in Figure 1.

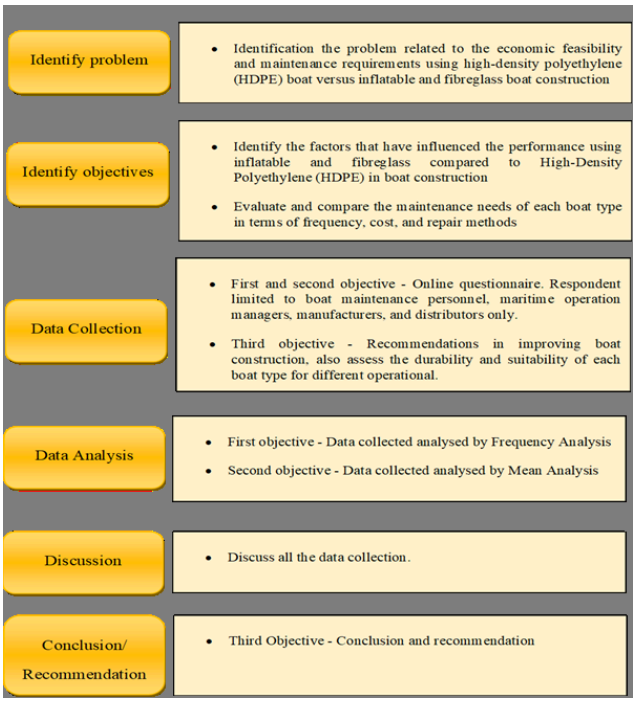


Figure 1. Research framework for factor identification, survey analysis and recommendations.

3.2 Sampling, survey distribution and instrument

The online questionnaire was prepared in Google Forms and circulated by email and social platforms, including WhatsApp and Facebook, among professionals involved with boat maintenance and maritime operations. Twelve participants were reported. Occupations included six boat-maintenance personnel, four manufacturing personnel, one marine drafter and one other maritime practitioner; no distributor category was separately identified in the final demographic chart. All 12 respondents reportedly selected the participation-consent option. No sampling frame, response rate, eligibility verification, item-level respondent records or institutional ethics-approval documentation is available; the study is consequently a convenience/purposive professional comparison rather than a statistically representative survey.

The instrument used four agreement levels: disagree = 1, slightly disagree = 2, slightly agree = 3 and agree = 4. Ten statements were presented for each of three maintenance dimensions: repair complexity, cleaning requirements and service intervals. Five repair questions concerned practical strengths, while five were negatively phrased; the cleaning and servicing batteries likewise mixed positively and negatively framed statements. The workshop-equipment availability wording appears twice among repair items, potentially double-weighting that consideration. The 30 complete question statements and associated recorded values are preserved in Tables 4–6.

3.3 Descriptive calculations

For each material and maintenance domain, the unadjusted mean of the ten displayed item ratings was calculated as $M = \frac{\sum_{i=1}^{10} x_i}{10}$, where x_i denotes the reported rating value for the ith questionnaire item. For a response-frequency table with counts by scale category, the correct arithmetic mean would be $M = \frac{\sum_{j=1}^{4} f_j \cdot j}{\sum_{j=1}^{4} f_j}$. Since the survey respondent-by-item frequencies are not provided, respondent-level means, dispersion, confidence intervals and test statistics cannot be recalculated independently. In this article, the ten-item averages are accurately described as averages of reported item ratings, not validated means of 12 observed respondent values.

3.4 Polarity and sensitivity analysis

Agreement with a statement such as “cleaning is easy” has a different interpretation from agreement with “cleaning requires specialised tools.” Therefore, descriptive comparison should not treat all high ratings as favourable. The recorded ratings remain unchanged in the primary tables. To illustrate interpretation sensitivity, a transparent exploratory reverse transformation, $x^* = 5 - x$, was applied only to clearly negatively worded items: repair items 6–10; cleaning items 8–10; and service items 2, 8 and 10. The resulting averages demonstrate how consistent polarity can affect the ordering. This transformation is a secondary analytical calculation, not evidence that the original questionnaire was coded in that way or that respondent records have been recovered. The wording of some questions remains conceptually debatable and may require author confirmation before final scale validation.

3.5 Economic feasibility and methodological limits

Economic feasibility would ordinarily require comparable purchase prices, service lives, annual repair expenditure, labour hours, downtime values, fuel and storage costs, discount assumptions and residual values. None of those vessel-level records accompanies the surveyed ratings. This study therefore interprets economic items as perceived affordability and possible mechanisms of cost avoidance rather than measured lifecycle cost, return on investment or net present value. The analysis is descriptive because of the small expert sample, incomplete item distribution data, unverified polarity handling and absence of a validated composite-scale instrument.

4. Results

4.1 Respondent characteristics and participation

All 12 recorded respondents (100%) indicated consent to take part. Figure 2 retains the recorded participation chart. The group consisted of 50.0% boat-maintenance personnel $\left(\frac{6}{12}\right)$, 33.3% manufacturing personnel $\left(\frac{4}{12}\right)$, 8.3% marine drafters $\left(\frac{1}{12}\right)$ and 8.3% professionals in another maritime role $\left(\frac{1}{12}\right)$. Figure 3 preserves the occupational composition chart. The distribution suggests practical experience in repair and fabrication but does not prove that every respondent had equivalent direct experience with all three materials.

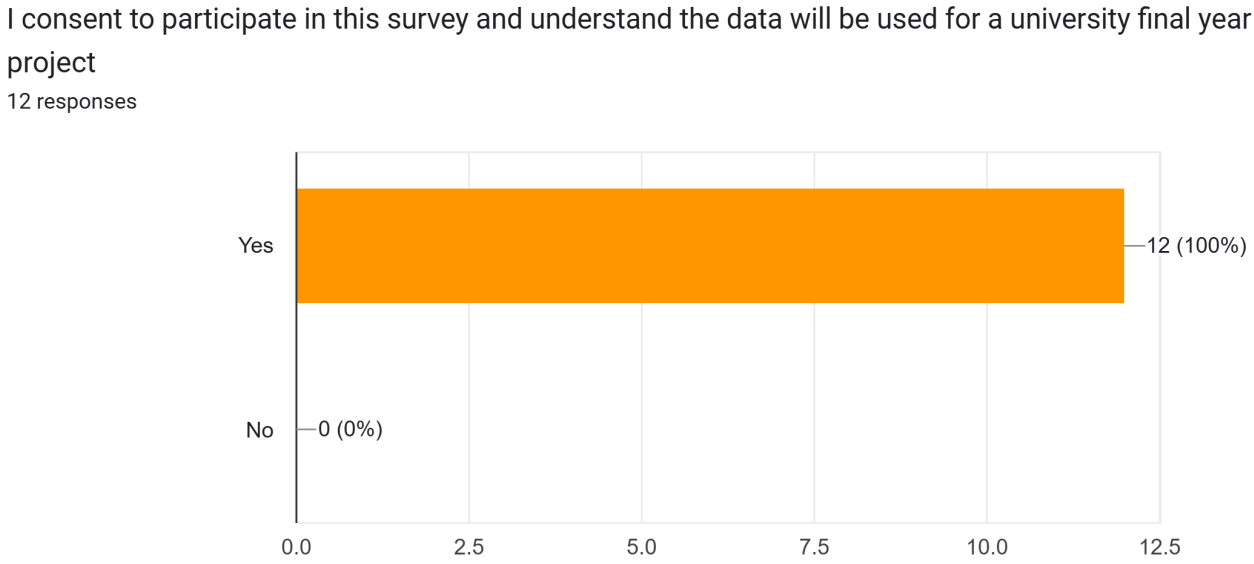


Figure 2. Reported survey participation consent (12 responses).

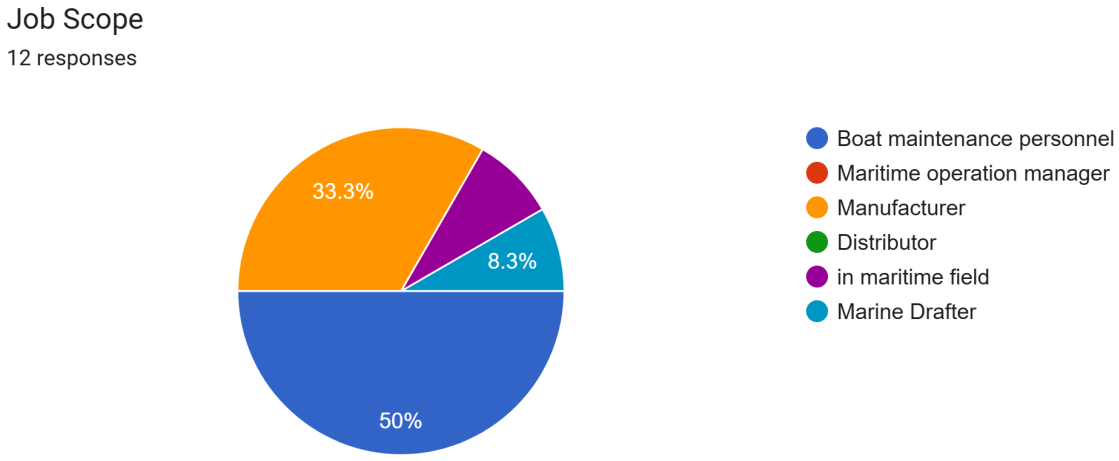


Figure 3. Reported occupational composition of the 12 participants.

4.2 Repair-complexity ratings

The first maintenance dimension addressed on-site repair access, local equipment availability, surface preparation, costs, required skills, sensitivity to environmental conditions and the consequences of poor repair technique. Table 4 retains the reported ten-item values. The unadjusted average was 3.80 for HDPE, 3.00 for fibreglass and 2.50 for inflatable construction. These are arithmetic summaries of displayed ratings and should not be interpreted as evidence that HDPE repair is always easiest: strong agreement with negative items such as specialist training and additional damage can indicate greater difficulty. The repeated equipment-availability question also affects weighting of the ten-item domain.

Table 4. Recorded repair-complexity questionnaire ratings (original response direction).

No.	Questionnaire item (original wording retained)	HDPE	Inflatable	Fibreglass	Polarity
1	Repair work can be performed externally without removing interior fittings or equipment.	4	2	3	Positive
2	Repair equipment for this hull type is commonly available at local workshops.	4	2	3	Positive
3	Surface preparation for this hull type (e.g., cleaning, sanding, heating) is simple and quick.	4	3	2	Positive
4	Repair equipment for this hull type is commonly available at local workshops. [repeated item]	3	3	2	Positive
5	The overall cost of repair equipment and materials is reasonable.	4	4	3	Positive
6	Training and certification are essential before undertaking repair work on this hull type.	3	2	4	Reverse
7	Repair quality depends heavily on environmental control (temperature, humidity).	4	2	3	Reverse
8	The repair process requires specific curing or cooling time management.	4	3	4	Reverse
9	Repairing this hull type requires highly specialised technical skills.	4	2	3	Reverse
10	Improper handling during repair may easily cause additional damage.	4	2	3	Reverse
	Unadjusted average of ten reported item ratings	3.80	2.50	3.00	Not a respondent mean

4.3 Cleaning-requirements ratings

The cleaning dimension encompassed cleaning speed, perceived environmental effects, resistance to staining, mechanical cleaning, worker safety, tools, cleaning while afloat and three negatively phrased requirements. The unadjusted item-rating averages were 3.90 for HDPE, 2.90 for inflatable and 2.60 for fibreglass (Table 5). The recorded HDPE ratings of 4 for “requires frequent cleaning” and 4 for “requires specialised tools” demonstrate why the high unadjusted value cannot be described as an unqualified low-maintenance score.

Table 5. Recorded cleaning-requirements questionnaire ratings (original response direction).

No.	Questionnaire item (original wording retained)	HDPE	Inflatable	Fibreglass	Polarity
1	Cleaning operations for this hull type can be completed within a short time frame.	4	3	3	Positive
2	Cleaning this hull type produces minimal environmental impact (e.g., chemical runoff, microplastics).	4	3	2	Positive
3	The hull material resists staining and retains its original appearance after cleaning.	4	3	3	Positive
4	Pressure washing or mechanical cleaning can be safely performed without damaging the surface.	4	3	3	Positive
5	The cleaning process for this hull type is generally safe for workers.	4	3	2	Positive

No.	Questionnaire item (original wording retained)	HDPE	Inflatable	Fibreglass	Polarity
6	The tools and cleaning materials needed are easily available locally.	4	3	4	Positive
7	Cleaning can be performed conveniently while the vessel remains afloat.	4	3	2	Positive
8	This hull type requires frequent cleaning to maintain operational performance.	4	3	2	Reverse
9	The hull surface of this material is easily scratched or damaged during cleaning.	3	2	3	Reverse
10	Cleaning this hull type requires specialised tools or cleaning agents.	4	3	2	Reverse
	Unadjusted average of ten reported item ratings	3.90	2.90	2.60	Not a respondent mean

4.4 Service-interval ratings

The service domain addressed consumable availability, inspection frequency, hull-condition stability, scheduling flexibility, unexpected service, manufacturer guidance, the consequences of longer or shorter intervals and maintenance downtime. The displayed item values yielded unadjusted averages of HDPE 3.50, inflatable 2.90 and fibreglass 3.00 (Table 6). The fibreglass figure of 3.00 follows directly from its ten recorded values. Both 3.00 and a conflicting 2.90 appeared in different summaries; the arithmetic sum supports 3.00. As elsewhere, agreement that frequent servicing is needed cannot be interpreted as a favourable outcome without reverse direction handling.

Table 6. Recorded service-interval questionnaire ratings (original response direction).

No.	Questionnaire item (original wording retained)	HDPE	Inflatable	Fibreglass	Polarity
1	Spare parts or consumables for regular servicing are readily available and affordable.	4	3	3	Positive
2	This hull type requires frequent inspections to avoid performance degradation.	3	3	3	Reverse
3	The hull condition remains stable for a long period between scheduled maintenance.	4	3	3	Positive
4	Service intervals can be easily adjusted according to vessel usage or season.	4	3	3	Positive
5	Unexpected maintenance needs between scheduled services are rare.	3	3	2	Positive
6	Service intervals are standardised and follow clear manufacturer recommendations.	3	3	4	Positive
7	Longer service intervals reduce the overall maintenance cost of this hull type.	3	3	3	Positive
8	This hull type requires frequent scheduled servicing to maintain optimal performance.	4	3	3	Reverse
9	This hull type contributes to reduced downtime during maintenance cycles.	3	2	3	Positive
10	Shorter service intervals for this hull type lead to higher environmental waste generation.	4	3	3	Reverse
	Unadjusted average of ten reported item ratings	3.50	2.90	3.00	Not a respondent mean

4.5 Cross-material comparison

Table 7 consolidates the same recorded values used in Tables 4–6. HDPE has the numerically highest unadjusted average in all three domains; that is a descriptive property of the displayed item ratings. Table 8 provides a polarity-adjusted sensitivity illustration based on the explicit item mapping described in §3.4. This alternate calculation

reduces the HDPE repair index below the inflatable repair index, confirming that scale direction is material to the interpretation of repair findings. The adjusted indices are illustrative and should not be characterised as validated psychometric domain scores.

Table 7. Unadjusted mean of ten recorded item ratings for each domain.

Category	HDPE	Inflatable	Fibreglass
Repair complexity	3.80	2.50	3.00
Cleaning requirements	3.90	2.90	2.60
Service intervals	3.50	2.90	3.00

Table 8. Illustrative polarity-adjusted indices after reversal of specified negatively worded items.

Category	HDPE	Inflatable	Fibreglass
Repair complexity	2.50	2.80	2.10
Cleaning requirements	3.20	2.80	2.70
Service intervals	2.80	2.60	2.70

5. Discussion

5.1 Interpreting the questionnaire findings in context

The apparent preference for HDPE in the unadjusted ratings is consistent with the broad practitioner interest in robust, corrosion-resistant thermoplastic structures. For small fishing, patrol and rescue craft, simplified hull repair access and potentially reduced surface treatment may be attractive. (Ridwan et al., 2022; Telak et al., 2023) provide relevant but application-specific examples of HDPE construction. Nonetheless, the descriptive rating outcomes do not establish comparative failure rates, tested vessel reliability, total labour demand or actual replacement cycles. These require systematic service-history evidence.

5.2 The consequence of mixed-direction survey items

An essential finding from re-examining the questionnaire structure is that the raw scores combine favourable and adverse statements. In the repair domain, the ten HDPE ratings average 3.80, but the five negatively worded items generally receive scores of 3 or 4. On a consistently favourable scale, those adverse agreements would be reversed. The exploratory sensitivity results then give repair indices of 2.50 for HDPE, 2.80 for inflatable and 2.10 for fibreglass, rather than the unadjusted ordering of 3.80, 2.50 and 3.00. This does not demonstrate that inflatable craft are superior; it demonstrates that the direction and scoring of questionnaire items must be resolved before making a strong comparative claim.

For cleaning, the illustrative corrected indices are 3.20 for HDPE, 2.80 for inflatable and 2.70 for fibreglass. For servicing they are 2.80, 2.60 and 2.70, respectively. These values depend on judgement about which statements are adverse and on the assumption that the displayed figures behave as four-point scores. The actual number of respondents selecting each choice is unavailable. More rigorous measurement should supply the response matrix, an item-key table, evidence of item comprehension and a documented rule for calculating domain scores.

5.3 Maintenance indicators are not lifecycle cost estimates

The research objectives combine maintenance requirements and economic feasibility, but these are analytically different outcomes. If material-specific repairs require less labour or cause fewer off-hire days, costs might decline; whether the net result is economically advantageous depends on acquisition price, market availability, fuel use, material and welding quality, service duration, financing and resale. The reviewed cost savings for mixed recycled boards in a four-GT fishing craft (Supomo et al., 2024) cannot be extrapolated to the surveyed HDPE boats. A future economic evaluation should compare vessel-matched alternatives under identical utilisation and maintenance-accounting boundaries, preferably through discounted total-cost-of-ownership analysis.

5.4 Suitability for mission profiles and structural constraints

Selection should respond to the intended mission. For patrol, rescue, aquaculture or coastal support, impact tolerance, ease of deploying repairs and supplier coverage may be particularly important; recreational craft may emphasise appearance, speed, comfort or light weight. However, HDPE thermomechanical properties, hull scantlings, welding and thermal deformation demand adequate naval-architecture verification (Firmanda et al., 2022;

Veritas, 2022). Inflatable systems bring distinct seam and tube inspection requirements, while fibreglass structures require appropriate laminate and coating maintenance. A mission-specific technical assessment is therefore preferable to applying a single unqualified material ranking.

5.5 Environmental implications and study limitations

The potential to recover or recycle thermoplastic material is meaningful, but real environmental performance depends on fabrication energy, production origin, durability, cleaning inputs, repair waste and end-of-life collection. Comparative lifecycle assessment is required before asserting that one hull system is universally greener (Pommier et al., 2015). The present evidence is limited by a 12-person professional sample, missing response-level dataset, an apparent duplicate survey statement, uncertainties concerning item polarity, the absence of reliability testing and the lack of controlled financial or operational records. Recommendations consequently identify candidates for further evaluation rather than proving universal HDPE superiority.

6. Recommendations

6.1 Boatbuilders and manufacturing facilities

Manufacturers could develop and document repeatable HDPE hull designs for clearly specified craft classes, apply suitable materials and welding procedures, evaluate long-term temperature and UV exposure, and maintain repair manuals. Where HDPE is considered for serial production, local fabrication and material sourcing should be evaluated against mould-based fibreglass production and available inflatable stock. Collaboration with classification and certification bodies can help standardise design, inspection, prototype trials and repair guidance.

6.2 Boat owners and operators

Operators should compare hull alternatives against mission profiles, payload, conditions of navigation, downtime tolerance and access to repair services. Maintenance records should separate hull repair, cleaning, coatings, consumables, personnel hours, missed operations and unscheduled incidents. Such comparable records would enable testing whether the perceived maintainability of HDPE translates to lower actual ownership cost in working fleets.

6.3 Maritime education and technical training

Training providers could introduce material-specific competency modules covering HDPE thermal welding, surface preparation, join inspection and repair limitations, together with fibreglass laminate repair and inflatable-fabric service procedures. A repair method that is feasible in principle is not automatically safe or inexpensive when trained technicians and suitable equipment are unavailable. Structured practical training and clear inspection criteria would therefore support the use of any of the three materials.

6.4 Policy, industry support and knowledge sharing

Government agencies, industry associations and boatyards may consider pilot programmes, technical guidance, repair networks and information exchanges that improve access to credible lifecycle evidence. Financial incentives should be evaluated only after comparing application-specific benefits, local supply chains and environmental impacts. Accredited repair centres and manufacturer–operator partnerships could facilitate consistent service standards for HDPE and conventional alternatives.

6.5 Research priorities

Future studies should recruit a larger, more balanced sample of owners, operators and repair professionals with documented experience across comparable craft. The questionnaire should avoid duplicate items, predefine favourable and adverse scoring, and report per-item distributions and reliability statistics. Vessel-level comparisons should combine measured downtime, repair hours, material cost, lifespan and relevant performance tests; analyses can then incorporate sensitivity to operating intensity, inflation systems, different HDPE grades, thermomechanical behaviour and local material recovery.

7. Conclusion

The comparison considered HDPE, inflatable and fibreglass small-boat construction through a targeted literature review and a descriptive survey of 12 maritime practitioners. The retained questionnaire data covered purchasing and operational expectations and three groups of ten maintenance indicators. Unadjusted ratings were numerically highest for HDPE in repair complexity (3.80), cleaning requirements (3.90) and service intervals (3.50). However, numerous negatively phrased statements were scored in the same direction as favourable statements; a transparent polarity-adjusted sensitivity analysis changes the repair ordering. These results therefore identify practitioner perceptions and measurement questions, not definitive comparative maintenance-performance scales.

The literature supports technical interest in HDPE for specific small-boat applications but also underscores the need for appropriate stability, scantling, material and fabrication assessments. No verified vessel-level cost or service-history dataset is available to demonstrate that HDPE delivers a lower lifecycle cost than otherwise comparable fibreglass or inflatable craft. The most justified recommendation is to advance material-specific design and repair capabilities while collecting consistently coded questionnaire responses and comparable financial and operational records. Such evidence is necessary before broader material-selection or subsidy decisions can be made.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used ChatGPT to assist with language refinement, grammatical correction, and improvement of the clarity and readability of the text. The authors subsequently reviewed, edited, and verified the content to ensure its accuracy, originality, and scientific integrity. The authors take full responsibility for the content of the published article.

Conflict of Interest

The authors declare that they have no known financial or non-financial conflicts of interest that could have influenced the research, analysis, interpretation, or publication of this manuscript.

Author Contributions

Data Availability

No public data available

Ethics Statement

Not applicable

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