

Technical Design and Investment Feasibility Analysis of a 30-GT Steel Fishing Vessel for Operations in the Java Sea [†]

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[†] Presented at the 2nd International Conference on Sciences and Techniques for Renewable Energy and the Environment, Al Hoceima, Morocco, 28–30 April 2026.

Abstract

Indonesia, as one of the world's largest maritime nations, has substantial fishery potential in the Java Sea, yet fleet modernization remains limited. This study proposes a novel integrated framework that combines computer-aided vessel design with techno-economic feasibility analysis for a 30-GT steel fishing vessel as a replacement for traditional wooden fleets. The novelty lies in the simultaneous evaluation of technical design parameters and investment performance within a single framework tailored to small-scale fisheries. The vessel, with principal dimensions of 16 m (L), 4 m (B), 1.85 m (D), and 1.2 m (T), demonstrates adequate stability and operational capability. Financial results show positive NPV and an IRR above the benchmark, confirming technical and economic feasibility. The results confirm that 30-GT steel vessels provide a technically and economically feasible solution to support sustainable fishery development.

Keywords: fishing vessel design; investment feasibility; steel fishing vessel; Java Sea fisheries

1. Introduction

Indonesia is recognized as one of the largest maritime countries in the world, consisting of more than 17,000 islands with a coastline exceeding 55,000 km and an Exclusive Economic Zone (EEZ) covering approximately 2.7 million km² [1]. This geographical condition provides Indonesia with abundant marine and fishery resources, making the fishery sector one of the strategic contributors to national food security, employment, and economic development [2]. In Southeast Asia, Indonesia consistently records the highest marine capture fishery production, reaching approximately 7 million tons annually, accounting for nearly 38% of the regional production [3]. The fishery sector also supports millions of livelihoods and plays an important role in sustaining coastal communities [4].

The Java Sea is one of the most productive fishing grounds in Indonesia and has long been a major center for marine capture fishery activities [5]. Fishery production in this region is dominated by pelagic species such as tuna, mackerel, and scads, which contribute significantly to both domestic consumption and export markets [6]. However, despite the vast potential of marine resources, the effective utilization of these resources still faces several challenges, including limited fishing vessel capacity, aging fleets, and the continued reliance on traditional wooden vessels [7].

Fishing vessels represent one of the most critical infrastructures in marine resource exploitation and fishery operations [8]. The availability of appropriate vessel designs



Academic Editors: Charaf Laghlimi,
Younes Ziat, Zakaryaa Zarhri,
Nouredine Lakouari and
Hamza Belkhanchi

Published: 20 August 2026

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significantly influences fishing efficiency, operational safety, and economic performance [9]. In Indonesia, the majority of fishing vessels are categorized as small-scale vessels, with a large portion below 5 gross tonnage (GT), indicating the dominance of traditional fishing operations [10]. However, vessels within the range of 20–30 GT are considered strategic for improving fishing productivity because they provide better operational range, increased storage capacity, and improved seaworthiness compared to smaller vessels [11,12].

In recent years, the modernization of fishing vessels has become an important issue in Indonesia's fishery development policies. One of the key challenges is the scarcity of high-quality timber traditionally used for wooden fishing vessels, which has encouraged the transition toward alternative materials such as steel and fiberglass. Steel fishing vessels offer several advantages, including higher structural strength, longer service life, and better adaptability to modern fishing equipment [13]. Consequently, the development of steel fishing vessels is increasingly considered a potential solution for sustainable fishery fleet modernization in Indonesia [14].

From an engineering perspective, the design of fishing vessels must consider various aspects such as hull form, stability, structural integrity, and operational efficiency [15]. Modern ship design processes commonly utilize computer-aided design (CAD) tools and naval architecture software to optimize hull geometry and vessel performance [16]. In addition to technical considerations, the economic feasibility of fishing vessels is equally important because vessel investment represents a significant financial commitment for fishermen and investors [17]. Financial evaluation methods such as Net Present Value (NPV) and Internal Rate of Return (IRR) are commonly applied to assess the profitability and sustainability of maritime investments [18].

Furthermore, the increasing demand for seafood products and the growth of fishery-related businesses in Indonesia have attracted the interest of investors in developing fishing fleets and supporting infrastructures [19]. Therefore, an integrated approach combining technical ship design and financial feasibility analysis is required to ensure that fishing vessel development can be both technically viable and economically sustainable [20].

Based on these considerations, this study aims to develop the technical design of a 30-GT steel fishing vessel intended for operation in the Java Sea and to evaluate its investment feasibility using standard financial indicators. The vessel design follows applicable regulations and classification standards issued by the Indonesian Classification Bureau (BKI) and relevant Indonesian maritime regulations. The results of this study are expected to contribute to the development of efficient and economically feasible fishing vessels that can support the modernization of Indonesia's fishery sector.

2. Research Methods

The research methodology used in this study is illustrated in Figure 1, which outlines the sequential stages involved in the design and feasibility assessment of a 30-GT fishing vessel. The process consists of several key steps, starting from data collection and preliminary design development to investment feasibility analysis and design validation. The first stage of the research involves collecting the necessary technical and operational data required for the vessel design process. This includes information on fishing vessel characteristics, operational requirements in the Java Sea, and relevant regulatory standards. Data sources consist of literature reviews, government regulations, and classification rules issued by the Indonesian Classification Bureau (BKI). Additional information regarding fishing operations, vessel dimensions, and fleet characteristics was also gathered from previous studies and fishery statistics.

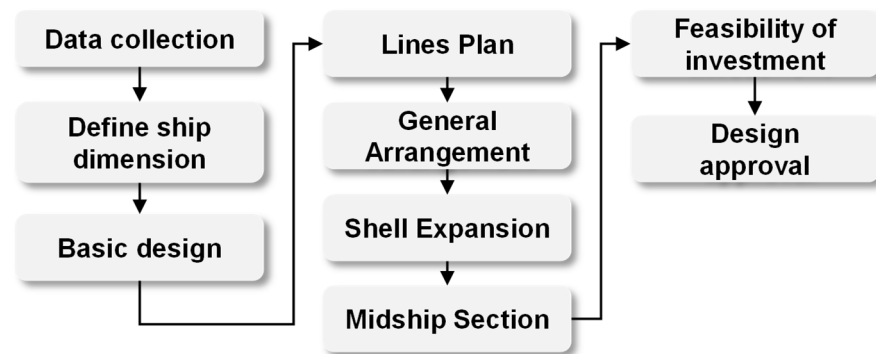


Figure 1. Research methods.

Based on the collected data and operational requirements, the principal dimensions of the fishing vessel were determined. These dimensions include the length overall (L), breadth (B), depth (H), and draft (T). The determination of these parameters considers fishing vessel operational needs, stability requirements, and typical vessel proportions used in vessels within the 20–30 GT category. After determining the principal dimensions, a preliminary or basic design of the vessel was developed. This stage defines the general concept of the fishing vessel, including hull form selection, deck layout, and operational arrangement. The basic design serves as the foundation for further detailed ship design processes. The line plan represents the geometric shape of the vessel hull and is an essential element in naval architecture design. In this study, the line plan was developed using Maxsurf software version 24.0.3.9, which allows the designer to model the hull surface and generate the necessary views such as the body plan, sheer plan, and half-breadth plan. The hull form is designed to ensure adequate hydrodynamic performance and operational efficiency for fishing activities in the Java Sea.

The general arrangement (GA) drawing defines the internal layout and functional spaces of the vessel. This includes the arrangement of the wheelhouse, engine room, fish hold, crew accommodation, and deck equipment. The GA design was developed using AutoCAD software web version 2025 and follows standard fishing vessel operational requirements. The midship section drawing represents the structural cross-section of the vessel at the midship area. This drawing provides detailed information regarding the structural arrangement, including plating thickness, framing system, and stiffener configuration. The structural design follows applicable rules from the Indonesian Classification Bureau (BKI) to ensure adequate strength and safety.

Shell expansion drawings illustrate the development of hull plating surfaces when unfolded into flat plates. This stage is important for ship construction because it provides guidance for the fabrication and cutting of hull plates during the shipbuilding process. In addition to the technical design, this study evaluates the economic feasibility of investing in a 30-GT fishing vessel using standard financial indicators, namely Net Present Value (NPV) and Internal Rate of Return (IRR). The financial analysis applies a discount rate of 10%, reflecting the prevailing bank interest rate in Indonesia, with an investment time horizon of 10 years corresponding to the vessel's economic service life. The cost structure includes initial capital investment (construction, equipment, and installation) and annual operational costs (fuel, crew wages, maintenance, and logistics). Revenue projections are estimated based on average catch capacity, fishing frequency, market fish prices, and typical operational days in the fishing grounds. Sensitivity to key assumptions such as fuel price and catch rate is also considered to ensure robustness of the results. Finally, the proposed vessel design is verified against the requirements of the Indonesian Classification Bureau (BKI) and relevant national maritime regulations to ensure compliance in terms of safety, structural integrity, and operational feasibility.

3. Result and Discussions

3.1. Hull Form and Technical Design Analysis

The research results obtained are in the form of ship drawings and an analysis of the feasibility of investing in a 30-GT fishing vessel. Several drawings have been made, namely line plan drawings, general arrangement, midship section, shell expansion and three-dimensional drawings. From the results of making a 30-GT fishing boat design using steel, it was found that the main dimensions of the boat are suitable for Java sea waters shown in Table 1.

Table 1. Ship particulars.

Specifications	Dimension	Units
Length overall (LoA)	16	m
Beam molded (B)	4	m
Depth (H)	1.85	m
Drafts (T)	1.2	m
Cargo capacity	25	m ³
Speed	10	Knots

The 30-GT fishing vessel line plan was created using several shipping parameters which were entered into Maxsurf software as shown in Figure 2. These parameters were obtained from comparison ships that had previously been built.

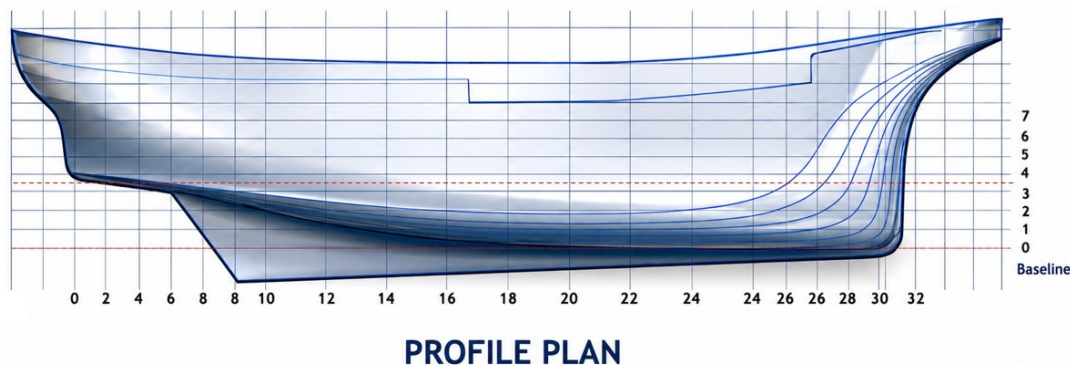


Figure 2. Profile Plan of 30-GT Steel Fishing Vessel.

The general arrangement drawing shown in Figure 3 is made referring to the line plan drawing that has been made. This general plan drawing explains the layout of the rooms and compartments on the ship, both the ship's hull and the superstructure of the ship [6].

The line plan shown previously was generated using Maxsurf software based on comparison vessel parameters and hydrostatic considerations. From the engineering perspective, the hull form directly influences ship resistance, propulsion power requirements, fuel consumption, and vessel operability. A slender hull configuration with moderate beam ratio was selected to reduce hydrodynamic resistance while maintaining transverse stability during fishing operations.

The midship section design was developed according to ship structural strength requirements. Steel construction provides higher structural rigidity and better load distribution capability than traditional wooden structures. The use of steel also improves structural reliability under cyclic wave loading and operational fatigue conditions. The shell expansion arrangement further demonstrates the engineering detailing of hull plate development and fabrication planning.

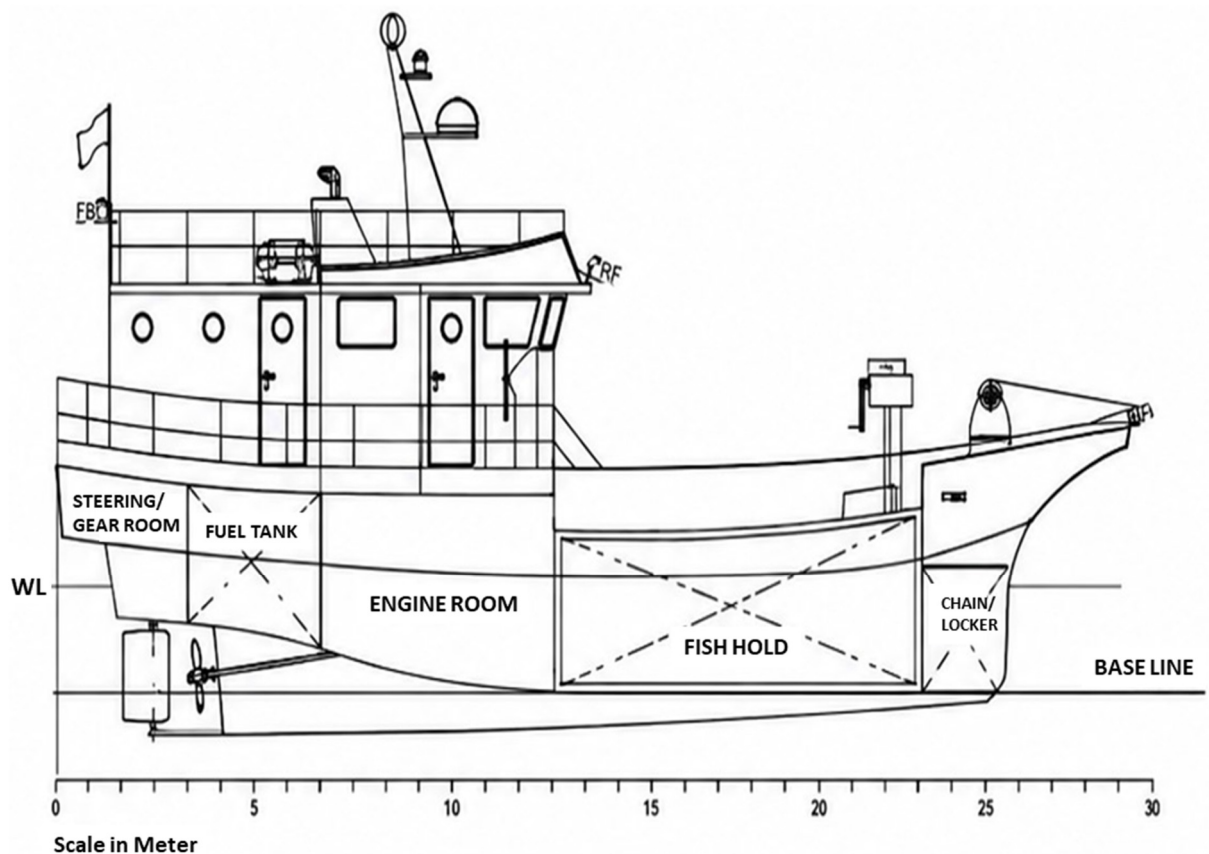


Figure 3. General arrangement of 30-GT Steel Fishing Vessel.

The vessel operational speed was determined at 10 knots to balance propulsion efficiency and fuel economy. Excessive speed increase would significantly increase wave-making resistance and propulsion power demand. Therefore, the selected operational speed is considered suitable for fishing vessel missions in the Java Sea. Electric load balance calculation is needed to determine the generator set on the ship [10]. Calculation of the estimated price itself is needed for financial analysis studies, namely as an investment value shown in Table 2.

Table 2. Owner estimated cost of 30-GT fishing vessel.

Component		Cost
Ship Material Costs	USD	48,755.08
Ship Equipment	USD	20,076.87
Engine and Pump Work	USD	34,228.31
Labor costs	USD	166,666.67
Miscellaneous expense	USD	5333.33
Total Before Tax	USD	275,060.26
Total After Tax (11%)	USD	305,316.88

3.2. Engineering Analysis of Diesel Propulsion System

Conventional diesel propulsion remains the dominant propulsion system for small and medium fishing vessels due to its operational reliability, mature technology, and extensive fuel supply infrastructure. In the proposed vessel, the diesel propulsion system

consists of a marine diesel engine connected to the propeller shaft through a mechanical transmission system as shown in Figure 4.

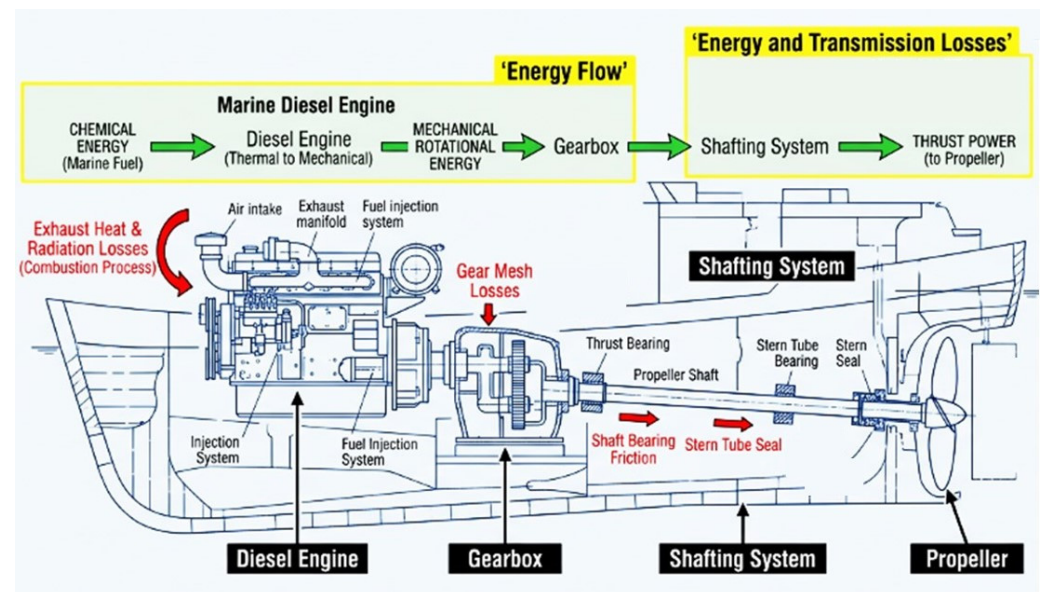


Figure 4. Diesel Propulsion System.

In this configuration, the diesel engine converts chemical energy from marine fuel into mechanical rotational energy, which is transmitted directly to the propeller. The propulsion system provides several engineering advantages, including high energy density, long operational range, rapid refueling capability, and stable propulsion performance under varying load conditions.

However, diesel propulsion systems also present several engineering limitations. Mechanical transmission losses occur in the gearbox and shafting system, reducing overall propulsion efficiency. Furthermore, diesel engines generate high vibration and noise levels, which may affect crew comfort and machinery durability. Combustion processes also produce greenhouse gas emissions, NO_x , SO_x , and particulate matter, contributing to environmental pollution.

From the operational engineering perspective, diesel propulsion offers high flexibility for fishing operations in the Java Sea because fuel availability is already well established in Indonesian fishing ports. The propulsion system is also more suitable for longer operational routes where battery charging infrastructure is unavailable.

The estimated machinery and engine installation cost for the proposed diesel fishing vessel reaches USD 34,228.31, representing a major portion of the shipbuilding investment cost.

4. Conclusions

This study demonstrates the technical and economic feasibility of a 30-GT steel fishing vessel designed for operation in the Java Sea. The proposed vessel, with principal dimensions of 16 m (LOA), 4 m (B), 1.85 m (D), and 1.2 m (T), meets operational requirements for fishing activities, crew accommodation, and fish storage, while ensuring adequate performance within typical fishing grounds. The estimated investment cost is USD 305,316.88, yielding a positive NPV of USD 71,876.61 and an IRR of 13.3%, exceeding the prevailing interest rate and confirming financial attractiveness. The adoption of steel construction offers improved durability and a practical alternative to increasingly scarce timber materials. Overall, the results confirm that the proposed design is technically viable and economically

feasible, supporting fleet modernization and sustainable fishery development. Future work should address hydrodynamic optimization and environmental performance.

Author Contributions: M.A.B.: conceptualization, methodology, formal analysis, investigation and writing—review and editing; A.F.U.: data acquisition, software, writing—original draft, RND: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding: This research supported by collaborative research between Universitas Indonesia and University of Birmingham referenced Award 1203656794.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data supporting the findings of this study are not publicly available due to confidentiality and institutional restrictions.

Acknowledgments: The authors would like to express their sincere appreciation to the Department of Mechanical Engineering, Universitas Indonesia, for providing research facilities and publication support. The authors also gratefully acknowledge the support from the project entitled “Zero Emission Cooling Hub for Small-Scale Fisheries,” funded by the British Council.

Conflicts of Interest: The authors declare no conflicts of interest.

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