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Published Papers (1988-1993)

on Fishing Vessels Design and Economics

by

Prof. Dr. M. A. Shama

1- "Factors Affecting Productivity of Coastal Fishing Vessel", AEJ, April, (Egypt-1988), Shama, M. A., (100%)

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OPERATIONAL COST ANALYSIS FOR COASTAL FISHING VESSELS

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Abstract

The annual operating costs of coastal fishing vessels are identified and analysed. The costs are divided into fixed costs and variable costs. The latter is subdivided into consumable costs and non-consumable costs. The main factors affecting each cost item are indicated and examined. Particular emphasis is placed on investment and crew costs. It is shown that it is possible to determine the highest investment cost compatible with a feasible volume of production, realistic fish price and a reasonable profit margin. It is also possible to determine the minimum fish price to satisfy a given investment cost and a reasonable profit margin.

Introduction

Improving the economy of coastal fishing could be realised by increasing annual revenues and reducing annual expenditures.Annual operating outlays for fishing vessels operating in coastal waters could be divided into predictable and unpredictable cost items. The major part of the predictable cost items is the cost of capital of the fishing vessel. The unpredictable cost items includes all the operational costs of the ship. It is also possible to divide the annual operating costs into fixed costs and variable costs. The latter costs could be also divided into consumble and non-consumable cost items.

The investment cost of a coastal fishing vessel depends on several design and operational parameters of which ship size, engine power, fishing equipment, degree of mechanisation and automation, etc., are the predominant factors. The investment cost, therefore, should be selected very carefully as it has a pronounced effect on the economic operation of the fishing vessel.

Crew share represents the largest single operating outlay and is usually taken as a certain percentage on the sales revenues. The selection of an appropriate value for the crew share should be examined very carefully so as not to impair the economics of the fishing operations.

This paper is an attempt to examine the main factors affecting annual expenditures of coastal fishing vessels so as to determine appropriate values of investment costs and crew shares compatible with the current conditions of fish prices.

1. Analysis of Annual Expenditure, E

The annual expenditure, E, could be divided into Fixed Expenses and Variable Expenses as follows:

$$E = E_F = E_V$$

a. Fixed Expenses, E_F

The fixed expenses are composed of:

- Annual Depreciation, E_D
- Cost of Capital, E_C
- Insurance, E_{IN}
- Overheads, E_O
- Fees, E_{FE}
- Maintenance and Repair (Routine Work), E_{MR}

Annual Depreciation, E_D, does not represent expenditure for the investor.

b. Variable Expenses, E_V

The variable expenses are composed of:

i. **Consumable Items**: Fuel Oil (E_{FO}), Lubricating Oil (E_{LO}), Ice (E_I), Fishing Gear (E_{FG}) and Provisions (E_{PR}).

ii. **Non-Consumable Items**: Commission (E_{COM}), Crew Share (E_{CR}), Accidental Repairs (E_{AR}), Interest on Operational Expenses (E_{OE})

It is evident that the minimum fish price per kg depends on the various cost elements, and reduces with increasing annual catch, see

Fig. (1).

In order to evaluate the minimum production to justify investment in coastal fishing vessels, it is necessary to identify and analyse the various cost elements.

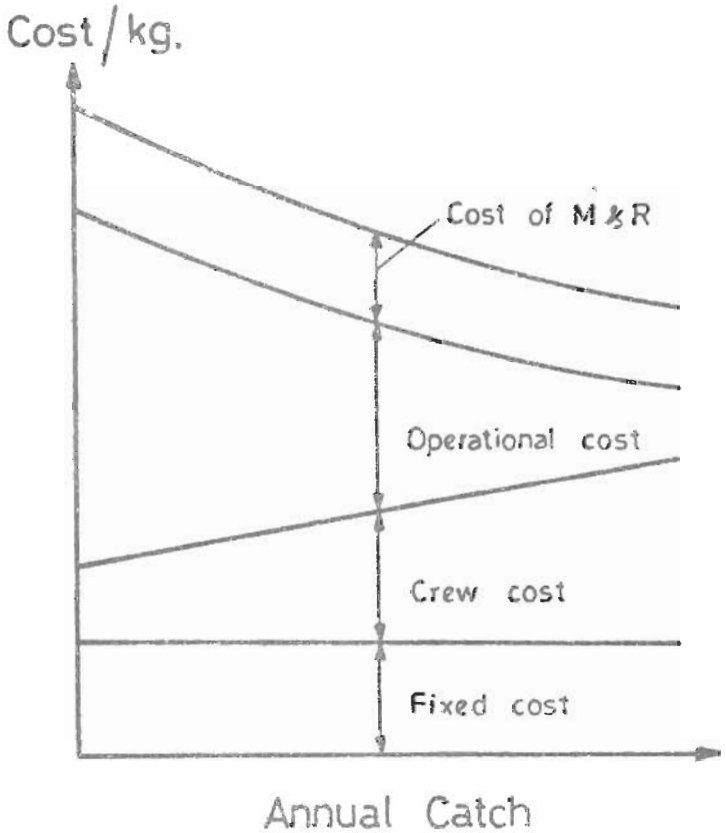


Figure (1) : Variation of Cost with Annual Catch.

1.1 Investment Cost

A fishing vessel is, in fact, an investment that earns its return. It is also an integral part of a global system for searching, catching, preserving and transporting fish in a good condition. The investment cost, therefore, should be compatible with the operational and economic conditions of coastal fishing.

The choice of a suitable type, size, fittings, etc. of a fishing vessel to operate in coastal areas depends on:

- Catch size and composition
- Average selling price of the catch
- Seasonal fluctuations
- Geographical and climatic conditions
- Social conditions
- Legal and regulatory requirements
- Depth of water in fishing port
- Availability of credit facilities, etc.

The initial cost to satisfy certain operational conditions, however, depends on the following main factors:

i. Material of construction
ii. Size of vessel
iii. Type, power, RPM of main engine
iv. Degree of mechanisation and automation
v. Quality and capacity of fishing equipment
vi. Quality and versatility of outfittings
vii. Quality and variety of electronic equipment
viii. Quality, number, etc. of crew accommodation.

In general, the cost of a fishing vessel could be divided into the following main divisions:

A. Steel hull: (including deck houses, F.O., F.W., and W.B. tanks, Rudder, Engine seatings, Masts, etc.).
This item represents about 25-35 %.

B. Main engine: (including stern gear, Shafting, Propeller, etc.).
This item represents about 20-30 %.

C. Fishing Equipment: (Trawlwinch, gallows, A-frame, anchors, chains, etc.
This item represents about 10-15 %.

D. Electronics: (Radar, echo sounder, fish finder, gyro compass, VHF, communication systems, etc.).
This item represents about 3-8%.

E. Auxiliary Machinery + Various Systems:
This item represents about 10 - 15 %.

F. Outfit work: (Bollards, fairlaids, etc.).
This item represents about 2-6 %.

G. Accomodation + Galley:
This item represents about 5-8 %.

H. Painting & Cathodic Protection:
This item includes shot blasting, primer coating; antirust coating,

antifouling, non-plip coatings, etc.
This item represents about 2-5 %.

I. **Miscellaneous:**
This item represents about 8-10 %.

In general, the building cost of a fishing vessel could be given by the following equation:

$$C_s = f_1(L) + f_2\ (C.N.) + f_3\ (LxB) + f_4\ (P_B^{2/3}) +$$
$$f_5\ (\text{crew No.}) + f_6\ (\text{Degree of Mechanisation}) + f_7\ (\text{Degree of}$$
$$\text{mation}) + f_8\ (\text{Auxiliaries}) + f_9\ (\text{outfittings}) + f_{10}(\text{miscellaneous})$$

$$\text{i.e.} \qquad C_s = \sum_{j=1}^{10} f_j x_j \ , \quad x_j = \text{different cost parameters}$$

1.2 Capital Depreciation

Fishing vessels are assumed to depreciate over a period of 10-20 years depending on hull material, effectiveness of maintenance and inspection work, competency of crew, etc.

Assuming straight line dpreciation, we have:

$$E_D = \alpha_D \cdot C_s$$

where :

E_D = Cost of depreciation

α_D = Rate of depreciation

C_s = Ship cost

1.3 Cost of Capital

The cost of capital includes annual instalments and interest on remaining part, and in general, depends on the conditions of the available loan.

i. Fixed instalments:

The annual cost of capital is given by:

$$E_{cj} = \frac{C_s}{n-g} \{ 1 + i(n-g-j) \}$$

where : i = rate of interest

n = loan period, years

g = grace period, years

C_s = borrowed capital

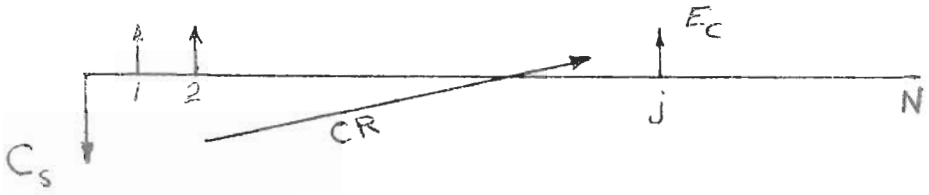
E_{cj} = cost of capital in year "j", j = g, g + 1,... n

N = ship life, years

ii. Initial Cost is Paid as Lump Sum

If the initial cost of the ship is paid by the owner as a lump sum at the beginning of the ship operation, the annual cost of capital is

given by (1):



$$E_C = (CR - i\,\% - N).\ C_s$$

where: CR = Capital Recovery Factor (1)

Therefore, the annual cost of capital is given by:

$$E_C = \alpha_C \cdot C_s$$

1.4 Insurance

The cost of insurance could be estimated as follows:

$$E_{IN} = \alpha_{IN} \cdot C_s$$

1.5 Overheads

The cost of overheads could be related to the capital cost of the ship as follows:

$$E_O = \alpha_O \cdot C_s$$

1.6 Maintenance and Repair

The total cost of maintenance and repair for a fishing vessel is the

sum of the different cost elements and could be evaluated as follows:

$$E_{MR} = E_P + E_H + E_A + E_E$$

where:
P,H,A and E relate to Propulsion system, Hull system, Auxiliaries, and Equipment respectively. However, the maintenance and repair costs could be simplified and treated as one item as follows:

$$E_{MR} = \alpha_{MR} \cdot C_s$$

1.7 Fuel Oil

The annual cost of fuel oil could be calculated as follows:

$$E_{FO} = b_f \times P_B \times 24 \times K \times m \times n \times C_f \times 10^{-3}$$

where:

b_f = S.F.C. kg/HP/hour
P_B = MCR of main engine
K = Power utilisation factor

$$K = \sum_{j=1}^{r} p_j \cdot t_j$$

m = number of fishing days/voyage
n = number of voyages/year
C_f = fuel price/tonne
p_j, t_j = Proportions of power and time of period j, see fig. (2).
r = number of periods of a fishing cycle.

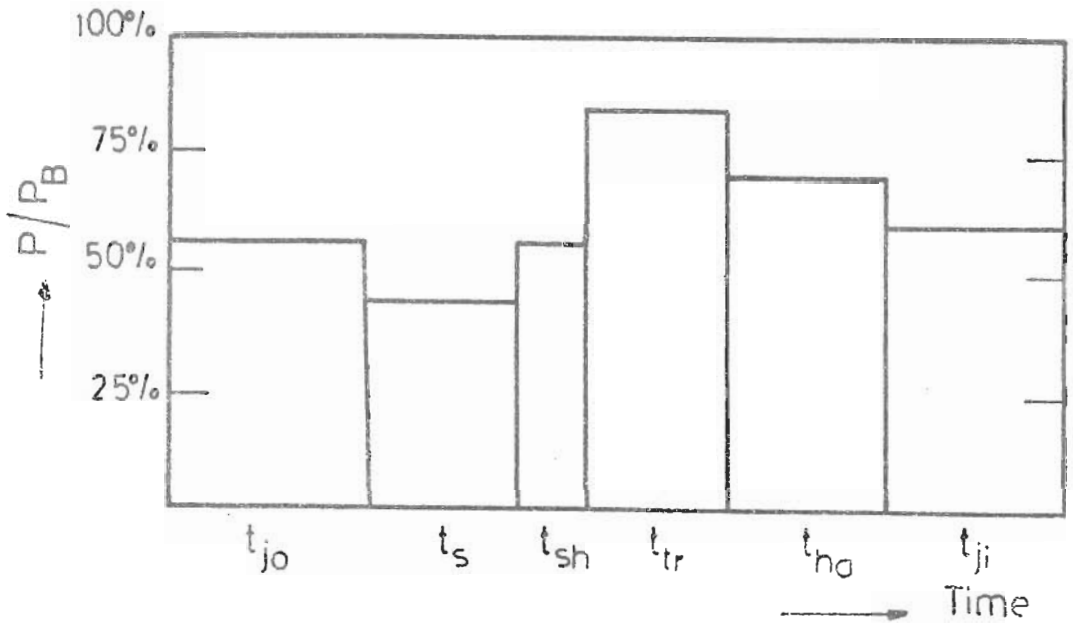


Fig. (2): Engine power utilisation per voyage

1.8 Lubricating Oil

The annual cost of lubricating oil could be calculated as follows:

$$F_{LO} = b_e \times P_B \times 24 \times k \times m \times n \times C_1 \times 10^{-3}$$

where:

b_e = Specific L.O. consumption

C_1 = L.O. price/tonne

1.9 Ice

The annual cost if ice could be calculated as follows:

$$E_I = b_i \times Q \times C_{ice}$$

where :

b_i = specific ice consumption/kg of fish

Q = annual fish caught, kg//year

C_{ice} = price of ice/kg.

1.10 Fishing gear

The annual cost of maintenance and repair of fishing gear could be estimated as follows:

$$E_{FG} = \alpha_{FG} \cdot C_{FG}$$

where: C_{FG} = cost of fishing gear

1.11 Provisions

The annual cost of provisions could be calculated as follows:

$$E_{PR} = C_{PR} \times J \times m \times n$$

where:

C_{PR} = cost of provisions/person/day

J = No of crew

1.12 Commission

The cost of commission depends on the value of the fish landed, and could be calculated as follows:

$$E_{COM} = \alpha_{COM} \cdot V$$

where :

V = value of catch

1.13 Crew share

The crew share depends on the fishing method and number of crew and could be estimated as follows (2):

$$E_{CR} = \alpha'_{CR} \cdot V$$

where $\alpha'_{CR} = \alpha_{CR} (1 - \alpha_{COM})$

1.14 Accidental Repairs

The cost of accidental repairs could be assumed as a certain percentage of the ship cost, i.e.

$$E_{AR} = \alpha_{AR} \cdot C_s$$

1.15 Iterest on Operational Expenses

The operational expenses are borrowed from the bank at an interest rate "i". The interest on these expenses could be evaluated as follows (1):

$$E_{OE} = (1+i) \cdot \Sigma E_j, \quad j = FO, \ LO, \ I, \ PR, \ CR$$

where: E_j = sum of operational expenses

2. Estimation of Annual Expenditure

2.1 Fixed Expenses

The total annual fixed expenses could be related to the initial cost of the ship as follows:

$$E_F = \alpha_F \cdot C_s$$

where:

$$\alpha_F = \Sigma\ \alpha_j, \quad j = D,C,\ IN,\ O,\ MR$$

where, D,C, IN, O and MR stand for: Depreciation, cost of capital, Insurance, Overheads, Maintenance and Repair.

It is possible to estimate α_F by analysing cost data from the operating fishing fleet.

2.2 Variable Expenses

The total annual variable expenses could be determined from the main cost elements as follows:

$$E_V = \Sigma\ E_j, \quad j = FO,\ LO,\ I,\ FG,\ PR,\ COM,\ CR,\ AR,\ OE$$

where:
FO, LO, I, FG, PR, Com, CR, AR, OE stand for fuel, lub. oil, ice, fishing gear, provisions, commission, crew share, accidental repairs and interest on operational expenses.

However, these variable cost elements could be combined into the

following equation:

$$E_v = \sum_{j=1}^{5} \alpha_j \cdot x_j \quad , \qquad x_j = q,\ Q,\ C_s,\ R,1$$

where: R = annual revenue

q = exploitation time

α_1 = a factor taking account of provisions, F.O. and could be easily related to egine power and number of crew.

α_2 = a factor taking account of ice consumption and could be directly related to fish production, Q.

α_3 = a factor taking account of expenses related to ship cost C_s.

α_4 = a factor taking account of crew share and could be related to the Revenue.

α_5 = a factor taking account of consumption of fishing gear.

3. Total Expenditures

The total annual expenditures, therefore, is given by:

$$E = \sum_{j=1}^{5} \alpha_j \cdot x_j \quad , \qquad x_j = q,\ Q,\ C_s,\ R,\ 1.0$$

4. Upper Limit of Investment Cost

The optimum value of investment cost for a projected fishing vessel should be compatible with the expected revenues and expenditures. Overinvesting in coastal fishing in areas having moderate stock values may have a deleterious effect on the economics of fishing. Under-investing, on the other hand, may reduce total annual expenditures but will have an adverse effect on fish production and

revenue. It is essential, therefore, to determine the appropriate value of the investment cost for a projected coastal fishing vessel so as to be compatible with the expected annual expenditures and revenues.

An approximate value for the upper limit of investment cost could be determined from the profit equation by substituting for R and E by their basic parameters:

$$P = R - E$$

Assuming that the profit "P" could be related to the investment cost "C_s", i.e.:

$$P = \eta \cdot C_s$$

where : η = Profit factor

Then, an expression for the limiting value of the investment cost of a coastal fishing vessel could be obtained in terms of the relevant Cost and Revenue parameters and an acceptable profit margin, as follows:

$$C_s \leq \{R\,(1 - \alpha_4) - \alpha_1 \cdot q - \alpha_2 \cdot Q - \alpha_5\} / (\eta + \alpha'_3)$$

This expression is represented in Fig. (3), which shows the variation of the limiting investment cost with the mean fish price for different values of fish catch rate and exploitation time and for specific values of profit factor, crew share, etc. Fig. (3) could be also used to obtain the limiting values of mean fish price for a certain

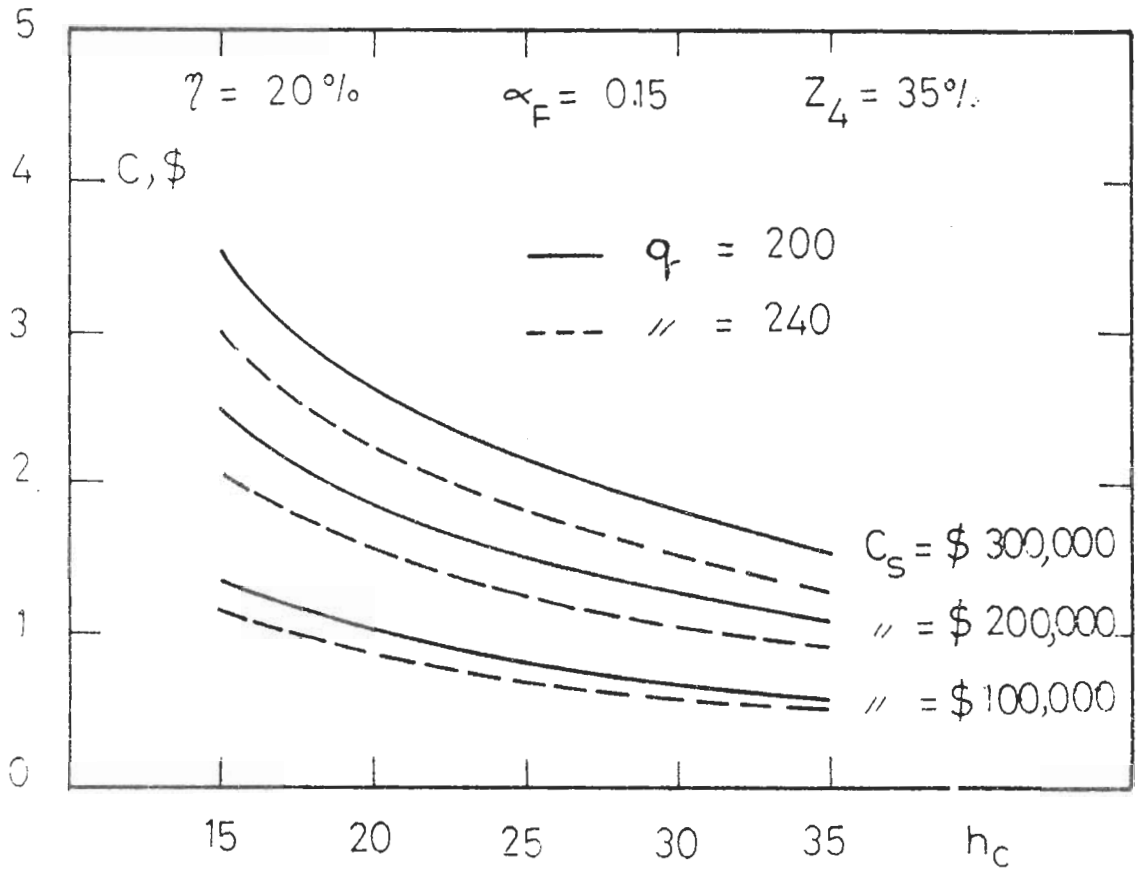


Fig. (3) Variation of fish price with catch rate

investment cost and operating conditions.

Similar expressions and curves could be easily developed for the particular case when the profit is related to the Revenue.

However, a more realistic value for the upper limit of investment cost should be based on future estimates of Revenues and Expenditures and

should take into account inflation rates.The estimates of future Revenues and Expenditures, however, are subject to elements of uncertainties. Therefore, the estimated limiting value of investment cost should be considered within the context of these uncertainties.

5. Example

It is required to estimate the limiting investment cost for a coastal fishing vessel operating under the following conditions:

Catch rate, kg/hour = 25

Average fish price per tonne = $ 1000

crew share = 40 %

α_1 = 24

α_2 = 0.01

α_5 = $ 2500

η = 15 %

Exploitation time, days/year = 240

α_3 = 0.20

Solution

Using the above data, the limiting investment cost is given by:

$$C_s = \$ 138,228$$

This price will only buy a modest coastal fishing vessel of length not exceeding 13.0 m.

6. Conclusions

From the foregoing analysis, the following conclusions could be drawn:

1. Annual expenditures of coastal fishing vessels could be subdivided into basic elements dependent on the main operational parameters such as:
   Investment Cost, Annual Revenue, Exploitation Time, etc.
2. It is essential to estimate the limiting value of investment cost for a projected coastal fishing vessel to operate under certain conditions so as to ensure an acceptable profit margin.
3. It is essential to collect data on all cost items. These data could be used to evaluate annual expenditures and limiting values of investment costs for projected fishing vessels.

7. References

[1] H. Benford, "Fundamentals of Ship Design Economics". The University of Michigan, August, 1965.
[2] M.A. Shama, "Factors Affecting Fishing Voyage Expenses and Efficiency", Alexandria Engineering Journal, Vol. 28. No. 2, April, 1989.