

Feasibility of Using Surface Piercing Propellers and Diesel Engine for Small Scale Fishing Boats

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ABSTRACT

The rising of fuel price globally has adverse effects on the small-scale fishing industry. Presently, Malaysian small fishing boats use petrol (gasoline) outboard motor. However, petrol outboard engines have higher fuel consumption compared to diesel engines. The higher relative cost of petrol adds to the problem. Efforts to introduce diesel engines to the small boats are hampered by the size of the engines and the suitability of propellers. This paper describes a study to determine the potential using combination of surface piercing propellers and diesel engine in small fishing boats. An analysis of fuel consumption reduction will be presented, together with an economic feasibility study. This economic review will identify the fuel savings gained as to determine the simple payback period on the initial cost and conclude the viability of using the system in terms of fuel and overall monetary savings.

KEY WORDS: *Inshore fishing, Fuel saving, Surface piercing propeller.*

NOMENCLATURE

NPV	Net Present Value
HP	Horsepower
SPP	Surface Piercing Propeller
RM	Ringgit Malaysia
EAC	Equivalent Annual Cost
FC	Fuel Consumption

1.0 INTRODUCTION

The national fishery sector production value is worth 10.26 billion ringgit and inshore fishing constitutes about 53.71 % from total value and nearly half of the vessel is powered by petrol outboard motor [1]. According to Pauzi et al. [2] fuel cost normally accounts for more than 50% of the annual operating expenses. The high fuel cost has exposed fishermen to uncertain future where fuel price in long term would keep increasing. Furthermore, the fisheries revenue is decreasing. Figure 1 shows a data of landing fish from 2006 to 2011. It can be seen from the graph that the fish landings value for inshore fishing shows a decreasing trend where offshore otherwise. This due to a small scale fishermen operation zone is limited to the coast or inshore because of the operations cost and safety factors as well as conditions of the boat that do not allow them to go further. Furthermore, alternative fuel saving technology such as solar and electric still far to be applied on traditional fishing boats due to lack of technology and financial constraints.

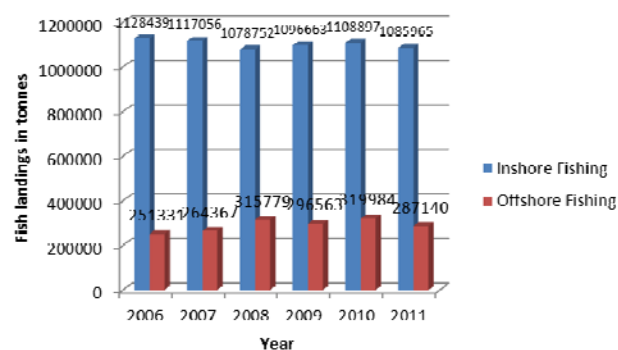


Figure 1: Landing of capture fisheries, 2006-2011[1].
It is believe that alternative methods such as promoting diesel

engine can be potential solution to the growing prices crisis. According to Wilson [3], a diesel engine is about 2.4 times more fuel-efficient than a petrol engine. This is similar to findings in [4] which describes fuel consumption trials of petrol driven outboard engine and inboard diesel engine at speed of 5.5 knots. The fuel consumption data exhibits inboard diesel consumes 1 litre per hour while petrol consumes 2.5 litres per hour at 4HP and 7HP respectively. It is about 60% saving. The data highlights that diesel engine promised a fuel saving over petrol outboard motor. Beside the great advantage, diesel engine can run on fuels from renewable sources. One of example is biodiesel. Biodiesel is has properties which is similar to conventional diesel. This strengthens the reason why diesel engine can be as future more stable than fossil resources. In our previous paper [5], we proposed an alternative propulsion system using diesel and surface piercing propeller for inshore fishing boats. It has been shown that a fuel saving gain than outboards with acceptable speed performance. The fuel consumption analysis reveals about 40 % fuel saving can be gained as shown in Figure 2.

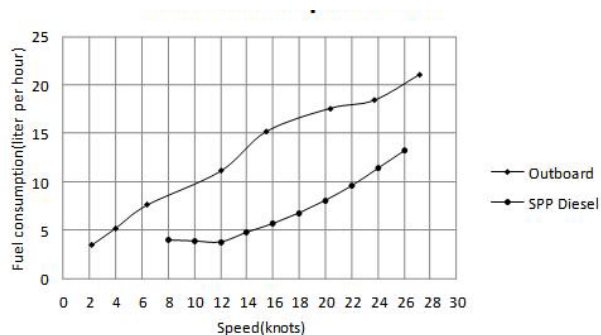


Figure 2: Fuel consumption curve comparison [5].

From the results, it can be a turning point for inshore fishing to adapt a diesel engine instead remains with outboard. However, the operation cost not only associated with fuel cost. it involves another such as initial cost and maintenance cost in order to meet the reality condition. Thus, the economic analysis should be carried out to validate the overall saving.

2.0 METHODOLOGY

In this paper, the fishermen community area at Manjung, Perak are selected as a location of case study and a 23 ft fiberglass fishing boat powered by 60 horsepower engine has been chosen. The methodology starts with identification of overall cost such initial cost, operation cost, maintenance cost, and salvage value. Other data required for this economic analysis such fuel consumption data, fishing route and fish catch, was based on estimation from findings and surveys. These data will be used to determine Net Present Value for both systems. During the research period, there is inconsistency in the data due to unstable economy market. As example, price of fuel changes several times while the research is conducted. Thus, some assumption has been made to simplify the economy analysis as follow:

- The duration for every trip is constant.
- Fuel consumption of both systems is constant for every trip.
- The price of petrol and diesel is constant along the year.
- The operational life is estimated for 10 years.
- The maintenance costs are equal for both systems.

Analysis will also take into account fuel price with subsidy and without subsidy to further investigate the benefits of proposed system.

3.0 RESULTS AND DISCUSSION

3.1 Fuel consumption analysis

Fuel consumption analysis is the key factor in this study. The fuel consumption of any is proportionally to power used. The more power used to achieve desired speed, the more fuel consumed. The calculation of power used will indicate accurate fuel consume for every trip. The best approach to determine the accurate total fuel consumed is by calculate the actual speed at particular fishing trip route. The trip route are divided into three phase which are from the port, open sea and fishing ground as shown in Figure 3.

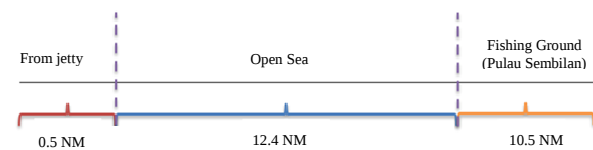


Figure 3: Fishing route.

The distance from jetty to river mouth is about 0.5 nautical miles. The common fishing ground for selected boat is Pulau Sembilan located 12.4 nautical miles from shore. From observation, the fishing route in fishing ground area is varying. It depends on the availability of fish stock and sea condition. Some of fishermen with higher engine capacity may go up to Pulau Jarak which is around 30 nautical miles off to west. From the figure, it can be seen that for every phase, the boat are propel at different speed level. From that, the average speed for each phase is calculated. The fuel consumption curve in Figure 2 is used to calculate fuel consumption per trip for each phase using interpolation method and results are presented in Table 1.

Table 1: Total fuel saving

	From Port	Open Sea	Fishing Ground	Total
Average speed(knot)	15.56	25.40	20.50	
FC outboard petrol (l/h)	15.22	19.71	17.62	17.52
FC SPP diesel (l/h)	5.50	12.66	8.51	8.89
Travelling time per trip (h)	0.01	2.00	1.00	3.01
Total fuel outboard (l)	0.15	39.42	17.62	57.19
Total fuel SPP diesel (l)	0.06	25.32	8.51	33.89
Fuel savings (liters)	0.10	14.10	9.11	23.31
Fuel savings (%)	63.86	35.77	51.70	40.75

The fuel consumption for each phase is calculated and summed. The fishing boat that uses outboard petrol consumes 57.19 liters of fuel per trip. If the boat uses SPP diesel it will consume approximately 33.89 liters of fuel per trip. For overall fuel consumption, the percentage of fuel reduction is determined by obtaining the difference between amount of fuel used by outboard petrol and SPP diesel. The difference then divided with fuel amount of outboard petrol and multiplied with 100 to get the percentage. By using SPP diesel, it would give 23.31 liters of fuel saving or 40.75 % in percentage. The fuel saving gained in other hand give an extra mileage to fishermen. The government is giving a subsidy to fishermen as incentive to reduce fuel burden among Malaysian fishermen.

At the moment the industries enjoys government subsidies for fuel prices for both petrol and diesel at RM 1.25. The market fuel price for petrol and diesel without subsidy is RM 2.10 and RM 2.00 respectively. However, there is the challenge is where government now is starting to reduce fuel subsidy. As example, in 2011, government has cut of subsidy for offshore fishing boats. Therefore, to access a monetary saving, the calculation will consider both subsidize price and unsubsidized price of fuel costs. Table 2 shows a total fuel costs per trip for both systems. The total subsidized fuel cost of outboard petrol is RM 82.93 and RM 49.13 for SPP diesel. Meanwhile total unsubsidized fuel cost of both systems is RM 120.10 and RM 67.77 respectively. If the government cutting out subsidies on fuel, the fuel cost for SPP diesel is RM 67.77 which is still lower than fuel cost of outboard petrol with subsidy.

Table 2: Monetary saving

	Total fuel (liters)	Total fuel cost with subsidy(RM)	Total fuel cost without subsidy (RM)
Outboard Petrol	57.19	82.93	120.10
SPP Diesel	33.89	49.13	67.77
Cost Savings		33.80	52.33
Cost Savings (%)		40.75	43.57

3.2 Economic analysis

The economic analysis is carried out to determine the profitability of the SPP diesel compared to outboard petrol. This will includes calculation of Net Present Value (NPV) and Equivalent Annual Cost (EAC). NPV is difference between the present value of cash inflows and the present value of cash outflows. Cash flows diagram are used to presents the summarized cost and benefits of projects over a time. Table 3 shows Net Present Value of both cases for comparison. For 10 years operational life, SPP diesel gives a savings of RM 3962 per year. This result has proved that using SPP diesel is more economical and monetary savings. From Figure 4 and Figure 5, it can be said that large portion of saving are gained from reduction in operation cost where majorly contributed by less fuel consumption of SPP diesel.

The aim of economic analysis is to determine whether a proposed system is feasible to be applied. In this study, two methods had been used, which were NPV and EAC. The use of NPV showed higher positive value at RM64636 for 10-year lifespan. It must be noted that the interest rate of 0.1 and salvage depreciation rate of 10% were used for this study, but those

values may not totally reflect the reality if inflation is extremely fickle.

Table 3: Net present value

	Outboard Petrol Engine	SPP Diesel Engine
Initial cost, P_0	RM 21000	RM 23200
Annual operation cost, A_1	RM 22971	RM 16213
Salvage value, F_0	RM 7322	RM 8099
Annual income, A_2	RM 30000	RM 30000
Interest rate, i	0.1	0.1
Lifespan, n	10	10
$(P/A/i/n)$ at 10%	6.1446	6.1446
$(P/F/i/n)$ at 10%	0.3855	0.3855
Net Present Value	RM25010	RM64636

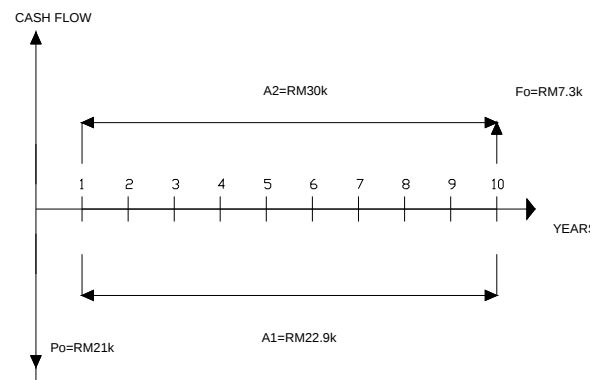


Figure 4: Cash flow diagram for fishing boat using outboard.

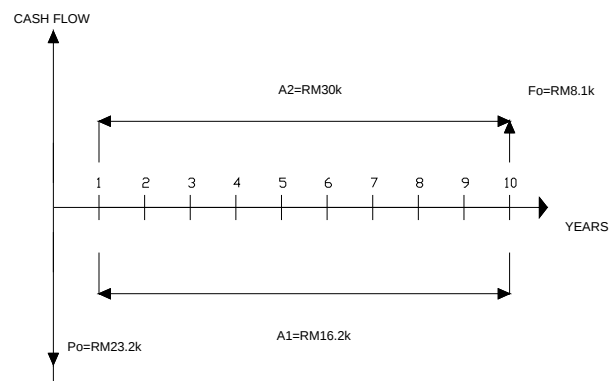


Figure 5: Cash flow diagram for fishing boat using SPP diesel.

The use of EAC can reduce the annual cost as much as 24%. The estimation of costs for proposed system, maintenance/repair and engine lifespan, however, might not be absolutely correct. However, as economic simulation, the most important is to achieve reduction in fuel consumption and fuel cost.

Even though the initial cost of SPP diesel engine is much higher than that of outboard engine, the expenditure can be reduced from operation cost. The operation cost per year for SPP diesel engine can be significantly reduced as much as RM6758,

which is majorly contributed from reduction of fuel cost. The use of diesel driven propulsion system instead of petrol outboard motor can result in considerable cost savings, and thereby improved economic performance.

4.0 CONCLUDING REMARKS

The outcome of this paper has proved the combination of diesel with SPP offer less fuel consumption compare to outboard. Techno economic analysis reveals that it financially viable to be adapt and increase the turnover fish landing and give a significance contribution to sustain fisherman livelihoods.

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