# **Economic Efficiency of Trawl Fisheries:**
# A Case of Trawl Fisheries in Nha Trang, Vietnam

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As in most countries in Southeast Asia, fisheries in Vietnam could also be considered as small-scale, multi-species and multi-fishing gears, and operated under an open access regime. While the number of fishing vessels of the country had continuously increased overtime, the CPUE had seriously reduced and the inshore resources specifically declined, which could be due to over-exploitation of the resources. Trawling operations notably by onshore bottom trawlers have allegedly contributed to the countries declining resources. However, trawlers which account for a huge proportion of the total number of vessels have also been responsible for landing large volume of fish catch. Thus, this study was conducted to evaluate the economic efficiency of trawl fleets focusing in Nha Trang City, Khanh Hoa Province, Vietnam. During the study, 57 trawlers which accounted for 13.7% of the total trawlers in Nha Trang were investigated with respect to their costs and earnings data. The empirical results showed that the owners of heterogeneous trawlers earn an average profit of 89.4 million VND corresponding to a profit margin of 12.8%. On the average, all economic indicators are positive although some trawlers have shown considerable losses. Furthermore, the results also showed that the medium group of trawlers (60≤Hp<90) is the most efficient group, although over-investment on particular trawlers in Nha Trang could also lead to economic inefficiency.

Khanh Hoa is a coastal province in South Central Vietnam, covering an area of nearly 5,200 km$^2$ with a coastline of 385 km and comprises more than 200 islands. In 2010, Khanh Hoa had 10,024 fishing vessels with the total engine power of over 328 thousands Hp, where 755 were offshore vessels accounting for 7.5% while the remaining were inshore vessels, of which about 50% had less than 20 Hp engines (Khanh Hoa DECAFIREP, 2010). The total fisheries production of the Province in 2010 was 93,000 metric tons, of which capture fisheries accounted for 73,000 metric tons or 78.5% of the total production (Khanh Hoa DARD, 2009). Fisheries in Khanh Hoa had therefore assumed an important role in the local economy, achieving high growth rate during the period from 2000 to 2010, contributing to the overall development of Khanh Hoa's economy, and positively impacting on the socio-economic conditions of the local fishing communities.

The fishing gears often used by fishers in Khanh Hoa are gill net, trawls (single or pair trawl), seine net (with or without light), hook and line (hand line and long line), and others. The main fishing grounds of Khanh Hoa fishers could be divided into two parts, *i.e.* offshore which include the South Eastern Sea, Truong Sa and South of Hoang Sa; and inshore such as the Cam Ranh long beach, Nha Trang Bay, Van Phong Bay, and Dai Lanh areas (Khanh Hoa DECAFIREP, 2010).

Fisheries in Khanh Hoa Province could be represented by that of Nha Trang because of its long traditional development and large number of fishing vessels of about 2,000 units accounting for 20% of the total number of vessels in Khanh Hoa. The fisheries sector in Nha Trang is one of the most important drivers of growth, being responsible for 42% of the city's GDP (Kim Anh *et al.*, 2006), of which trawl fisheries contributed a huge portion in terms of catch and revenue. The 416 trawlers in Nha Trang account for 33% of the total trawlers in Khanh Hoa and 21.5% of the total vessels in Nha Trang. Trawls which ranked third among the major fishing gears used in Nha Trang after gill nets and seine nets, play an important role in the development of open-access fisheries in Nha Trang.

Although several studies on the economic performance of fishing gears have been conducted using cost and earnings data, such as those by Kim Anh *et al.* (2006) on gill net vessels, Kim Anh *et al.* (2007) and Long *et al.* (2008) on



Map of Vietnam indicating Khanh Hoa Province offshore long liners, and Duy *et al*. (2010) on offshore gill net fisheries, studies on trawlers especially the bottom trawlers and "fly-trawlers" which are considered destructive (Dong, 2004), have been rarely undertaken. This study therefore, attempted to determine the economic efficiency of trawl fleets in Vietnam in general and Nha Trang in particular.

## Data Collection

For the study, the data collected include costs and earnings, as well as technical and operational information such as size of vessels, mesh size of fishing gears, number of crew, fishing costs, and number of days at sea per trip and per month. For the data on revenue, the average yield per trip was considered taking into account the species caught which had been grouped and the corresponding prices of the species determined. However, considering the various species in the trawl catch, these have been classified into five groups according to market price, such as "marketed species", big squid, small squid, shrimps, and trash fish. Thus, the fishing trip's revenue could be easily calculated using the quantity of the grouped species multiplied by their corresponding prices.

For some trawlers that could not provide the quantity of fish caught, the average total revenue (gross revenue) of each trip is multiplied by the average numbers of fishing trips annually. Using such information, the economic indicators are calculated based on the following scheme: ***Gross Revenue - Variable costs = Income - Fixed costs = Gross value added – Labors cost = Gross cash flow – Depreciation - Interest loans payment = Profit - Calculated interest on owners' capital = Net profit***

In fisheries, fishing effort could include many factors that impact on the efficiency of fishing vessels, such as length of the vessel, engine power, fishing time, crew size, experience of vessel captain or crew, and fishing gear (FAO, 2003). Therefore, fishing effort measures the level of activities of the fishing vessels, and in the case of trawl fisheries in Nha Trang, engine power, fishing gear and the number of fishing days are considered the major factors that affect the economic efficiency of the trawl fleets.

Sorting of catch onboard a trawler in Nha Trang

Fishing effort has been established taking into account the technical and operational characteristics of fishing vessels, and could be illustrated as:

$$EFFORT_i = A * Hp_i^{\alpha_1} Gear_i^{\alpha_2} Day_i^{\alpha_3}$$

where,
$EFFORT_i$ is the fishing effort of vessel i, the gross revenue (in million VND) is chosen as a proxy;
$Hp_i$ is the engine power of vessel i (measured in Horsepower);
$Gear_i$ is the circumference of the mouth of the trawler (measured in meters);
$Day_i$ is the number of fishing days of vessels i;
$\alpha_1$, $\alpha_2$, $\alpha_3$ are estimated coefficients;
***i*** is the rank of the vessels (1 to 57 vessels); and
*A* is a constant.

In the traditional production function, Y = f(K;L), labor is one of the major factors that affect the output Y. However, labor is not included in the aforementioned fishing effort model because of the following reasons: Firstly, trawlers in Nha Trang had been fully equipped with facilities and instruments such as roller, GPS and with at least 2 trawl nets per vessel. Almost all manpower engaged in the fishing activities had been replaced by machines (*e.g.* rollers).

Secondly, the number of crew on trawlers often varied from 3 to 5 members including the vessel captain. From the equation above, the log linear gross revenue for vessel ***i*** can be determined using the following equation:

$$LnEffort = \alpha_{0} + \alpha_1 LnHp + \alpha_2 LnGear + \alpha_3 LnDay + \varepsilon$$

where $\alpha_0$ = LnA (constant) and $\varepsilon$ is the random error

Using the production function method, the standardized fishing effort could be estimated and the catch per unit effort (CPUE) is often used as the fishing effort.

However, in view of insufficient data on fisheries yield as well as individual vessels, the gross revenue is used to analyze the regression and as proxy for the fishing effort. In this case, the price of fish is assumed fixed for all vessels, the total landings do not impact on fish prices and the time of fishing operation is within one year (*i.e.* in 2011). Thus, the standardized fishing effort (SFE) of each vessel could be estimated together with the average standardized fishing effort ($\overline{SFE}$) of all sampled vessels.

The relative standardized fishing effort (RSFE) is calculated by dividing the standardized fishing effort of each vessel by the average standardized fishing effort:

$$RSFE_i = \frac{SFE_i}{\overline{SFE}}$$

where *RSFE* is the relative standardized fishing effort of each vessel, *SFE* is the standardized fishing effort of each vessel; $\overline{SFE}$ is the average standardized fishing effort of the samples, and ***i*** is the vessel ID (*i.e.* from 1 to 57).

## Results

**Calculated values of the economic efficiency indicators**

In 2011, the key economic efficiency indicators of 416 trawlers in Nha Trang have been identified as shown in **Table 1**. The indicators include gross revenue, operational costs (variable costs, maintain, repair and insurance costs), labor cost, fixed costs (annual repair and maintains, insurance and registrations fee), depreciation, loan interest payment, and the calculated interest on owner's capital.

**Table 1** shows that the annual gross revenue of trawl fleets in Nha Trang in 2011 varied from around 304.4 million to 1,286.2 million VND with an average of 691.2 million VND, which is three times greater than the gross revenue of trawlers in 2005 and 2006. The average revenue of trawler fleets in Nha Trang in 2006 was only 205.8 million VND (Ngoc *et al*., 2009). Moreover, trawl fleets in Nha Trang had also improved in 2011 in terms of capacity as engine power or hull length have been significantly developed.

**Table 1.** Economic performance of the indicators of sampled trawls (in million VND)

| Indicators | Min | Max | Mean | S.D. |
|---|---|---|---|---|
| **Gross Revenue** | **304.4** | **1,286.2** | **691.2** | **254.1** |
| Variable costs | 168.9 | 752.2 | 361.2 | 145.3 |
| **Income** | **95.2** | **638.6** | **330.0** | **133.8** |
| Fixed costs | 30.8 | 102.0 | 49.0 | 18.0 |
| **Gross value added** | **59.4** | **572.7** | **281.0** | **121.8** |
| Labors cost | 47.7 | 387.0 | 166.9 | 87.8 |
| **Gross cash flow** | **- 19.6** | **236.0** | **114.2** | **51.7** |
| Depreciation | 12.0 | 45.0 | 23.5 | 9.6 |
| Interest loans payment | 1.8 | 15.0 | 7.5 | 4.3 |
| **Profit** | **- 34.6** | **221.2** | **89.4** | **50.1** |
| Calculated interest on owners' capital | 11.2 | 91.0 | 33.9 | 16.5 |
| **Net profit** | **- 57.5** | **197.5** | **55.5** | **49.2** |
| Gross profit margin (%) | - 5.3 | 29.8 | 16.6 | 6.8 |
| Profit margin (%) | - 9.3 | 25.0 | 12.8 | 6.9 |
| Return on owners' capital (%) | - 13.0 | 60.5 | 26.0 | 14.8 |
| Annual income per fisher | 15.9 | 56.6 | 31.8 | 10.8 |

While the average engine power and hull length in 2006 was only 35.3 Hp and 11.6 meters (Ngoc *et al*., 2009), in 2011 these had increased to 82.5 Hp and 13.9 meters, respectively. However, the annual gross revenues of long liners and gill net fleets in Nha Trang at 845.0 million VND and 1,073.7 million VND, respectively (Long *et al*., 2008 and Duy *et al*., 2010) were still higher compared with the revenue of trawlers considering that long liners and gill net fleets catch more economically-valuable species.

**Table 1** also shows that the variable costs ranged from about 170.0 to over 750.0 million VND with an average of 360 million VND, equivalent to about US$ 17 thousand, which are likewise much smaller than variable costs of gill net fleets in Nha Trang in 2005 at more than US$ 35 thousand (Kim Anh *et al*., 2006). Income which is the difference between the gross revenue and the variable costs ranged widely from 95.2 to 638.6 million VND and averaged at 330.0 million VND. Fixed costs which averaged at 49.0 million VND, ranged from 30.8 million to 102.0 million VND. The gross value added, which is the result subtracting the variable costs and fixed costs without labor costs from the gross revenue, varied from 59.4 to 572.7 million VND with an average of 281.0 million VND. The labor costs for crew members had a mean of about 170.0 million VND per vessel, and varied from 47.7 to 387.0 million VND in 2011. After subtracting the labors costs, the mean of gross cash flow is 114.2 million VND which accounts for 16.6% of the gross profit margin. The average depreciation of the sampled vessels also varied from 12.0 million to 45.0 million VND at an average of about 23.5 million VND. Moreover, the average loan interest which was 7.5 million VND, ranged from 1.8 million to 15.0 million VND. Finally, the calculated interest on owner's capital for the sampled vessels was 33.91 million VND ranging from 11.2 million to 91.0 million VND.

Moreover, the values of the key economic indicators of the trawlers in terms of engine power were also calculated in order to have a deep insight on the costs and earnings of trawler fleets. Focusing on costs (variable costs and fixed costs) as well as earnings (gross revenue, gross cash flow and net profit) of the trawlers, the values shown in **Table 2** suggest that trawlers with larger engine power could incur higher variable costs, especially on fuel cost. This is mainly because bigger vessels with higher capacity engine are able to go for longer trips in far offshore areas.

Consequently, these large vessels provide higher gross revenue (assuming that price of fish is fixed in a short-term (based on January 2012 prices) and fish landing quantity does not affect the price of fish). Although, catch and

**Table 2.** Economic performance indicators of trawlers by groups (in million VND)

| Indicators | HP<60 (n=26) | | 60≤Hp<90 (n=14) | | Hp≥ 90 (n=17) | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| Gross Revenue | 508.3 | 162.1 | 758.3 | 176.0 | 915.5 | 219.2 |
| Variable costs | 283.4 | 110.2 | 345.3 | 74.7 | 491.3 | 145.6 |
| **Income** | **224.9** | **72.0** | **413.0** | **125.1** | **421.2** | **96.7** |
| Fixed costs | 34.3 | 4.3 | 54.0 | 9.6 | 67.2 | 17.2 |
| **Gross value added** | **190.7** | **73.0** | **359.0** | **120.4** | **354.0** | **88.8** |
| Labors cost | 215.6 | 62.6 | 216.1 | 111.1 | 108.5 | 43.0 |
| **Gross cash flow** | **82.1** | **42.8** | **142.9** | **42.7** | **138.5** | **45.6** |
| Depreciation | 17.4 | 4.1 | 22.2 | 8.4 | 33.7 | 8.3 |
| Interest loans payment | 6.2 | 2.8 | 11.3 | 5.3 | 6.3 | 6.4 |
| **Profit** | **63.8** | **41.8** | **119.1** | **43.8** | **104.0** | **49.2** |
| Calculated interest on owners' capital | 21.3 | 5.3 | 36.3 | 9.0 | 51.1 | 16.0 |
| **Net profit** | **42.5** | **40.6** | **82.8** | **44.9** | **52.9** | **57.7** |
| Gross profit margin (%) | 15.8 | 8.5 | 19.3 | 4.9 | 15.5 | 4.3 |
| Profit margin (%) | 11.9 | 8.6 | 16.0 | 4.8 | 11.6 | 4.6 |
| Return on owners' capital (%) | 23.4 | 17.2 | 34.8 | 10.5 | 22.4 | 10.6 |
| Annual income per fisher | 36.2 | 14.3 | 49.8 | 19.5 | 44.2 | 11.9 |

revenue could be higher with large vessels, higher variable costs could be incurred compared with the small vessels. Thus, the average income of the medium group of vessels (60≤Hp<90) appeared to be almost equal with that of larger vessels (Hp≥90), and after subtracting all expenses, the net profit of the medium group of vessels is higher than that of the big vessels. This is because fishing costs (variable costs, labors cost, etc.) increase over time, and although fish price could also go up but the rate of increase in fish price is not the same as that of the increasing costs. As a consequence, over-investment could lead to inefficiency in case of trawl fisheries in Nha Trang, in particular.

efficiency of 57 heterogeneous trawlers in Nha Trang surveyed in 2011 for the study.

Meanwhile, the average cost per unit effort and relative standardized fishing effort are illustrated in **Fig. 3** by the vertical and horizontal axis, respectively. While the height of the bar measures cost efficiency, the relative standardized fishing effort is measured by the width of the bar. The trawlers are arranged from left to the right according to their decreasing cost efficiencies. Thus, trawler ID 29 and ID 9 are the most and the least cost efficient, with 354.1 million and 812.8 million VND per unit effort, respectively.

## Cost efficiency of trawlers

**Fig. 1** shows the results after estimating the fishing effort and calculating the relative standardized fishing efforts for each sampled trawler. In this case, trawler ID 37 and ID 54 incurred the lowest and highest cost, respectively, which had been derived by dividing the total variable cost of each trawler by the relative standardized fishing effort of each trawler.

The Salter diagram shown in the succeeding **Fig. 2** indicates the relationship between the relative standardized fishing effort and cost

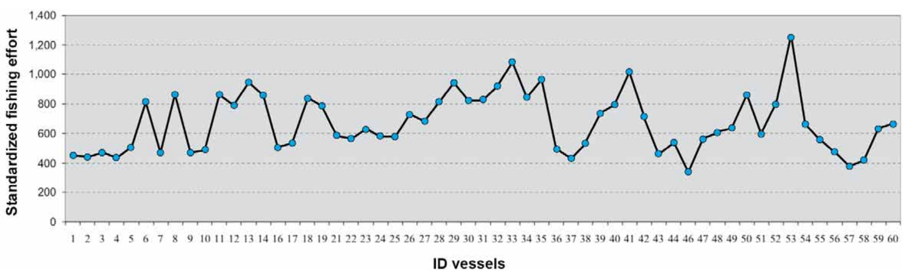


**Fig. 1.** Standardized fishing effort of observed trawlers in Nha Trang in 2011

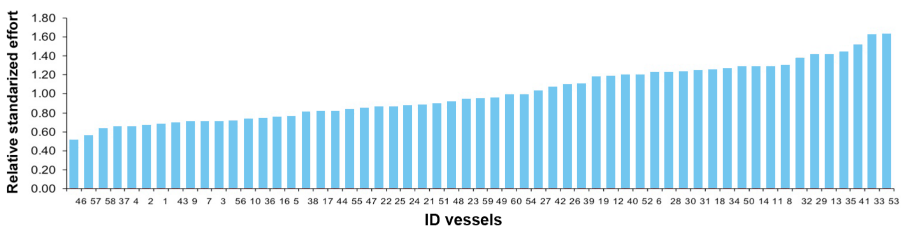


**Fig. 2.** Relative standardized fishing effort of trawlers in Nha Trang in 2011

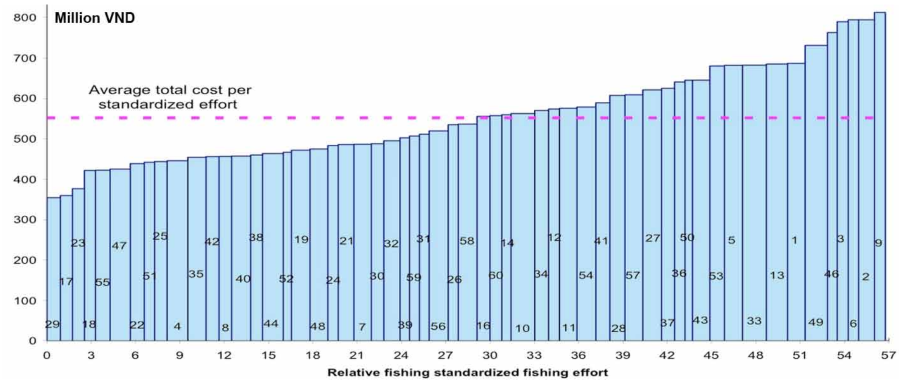


**Fig. 3.** Cost efficiency per relative standardized fishing effort in the short run

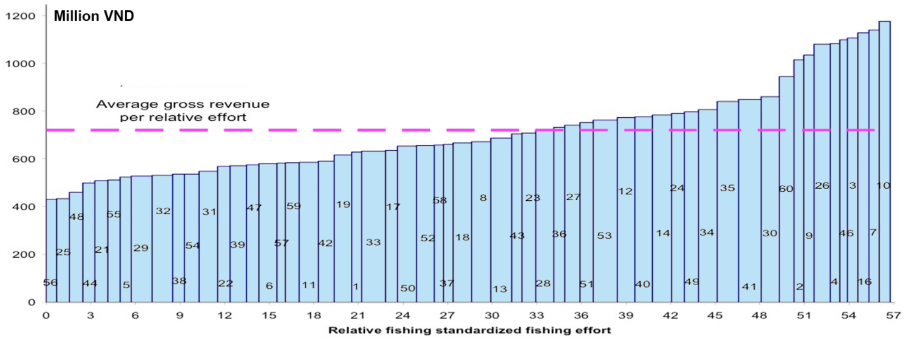


**Fig. 4.** Gross revenue per relative standardized effort fishing of trawl fleets in Nha Trang

Various species caught by trawlers in Nha Trang include small shrimps and trash fish

Specifically, the corresponding relative standardized fishing efforts of trawler ID 29 and ID 9 was 1.41 and 0.70, respectively. In addition, trawler ID 54 was chosen as the standard vessel (with AVC54 at 404.7 million VND per unit effort) with relative standardized fishing effort of almost 1.00 against which the effort of the other vessels is measured. Accordingly, 25 vessels had relative standardized fishing effort of more than 1.00, of which, 17 vessels had average variable costs of less than 404.7 million VND (AVC54), *i.e.* vessel ID 42, 26, 39, 19, 12, 40, 52, 30, 31, 18, 34, 14, 11, 8, 32, 29, and 35 (**Fig. 4**). These trawlers were considered to be more cost efficient than the standard vessel (ID 54) in their fishing operations under the open-access fisheries regime.

## Discussion

### Technical and operational characteristics of trawlers in Nha Trang

Based on the average physical characteristics of trawlers in Nha Trang (hull length, hull width and engine power), it can be said that the current capacity of trawlers has improved considerably compared with that of the previous years. Specifically, the average engine power and hull length of trawl fleets in Nha Trang increased from 35.3 Hp and 11.6 m in 2005 (Ngoc, *et al.*, 2009) to 82.5 Hp and 13.9 m, respectively, notwithstanding other fleets such as long liners and gill nets which had higher engine capacity. While the average length and engine power of long liners are 15.1 m and 121.9 Hp, respectively (Long *et al.*, 2008) that of gill net fleets are 16.4 m and 249.6 Hp, respectively (Duy, 2010). Therefore, trawl fleets in Nha Trang are smaller than long liners and gill net fleets in terms of the physical characteristics of the vessels. As a consequence, the average annual number of fishing days of trawlers is lower than that of the other fishing gears. This is due to the far distance that long liners and gill netters often go and the longer trips undertaken, while trawlers usually operate nearshore and undertake three to five fishing days per trip. In 2011, trawlers in Nha Trang went to sea at an average of 225 days corresponding to 54 trips per year and an average of 4.6 days per trip. This trend is almost the same as the gill net fleets in 2009 with 231 fishing days (Duy, 2010), but much longer than long liners in 2008 of which 100 days was spent at sea on the average (Long *et al.*, 2008).

Meanwhile, the medium group of trawlers usually spends 206 days at sea and the other two groups approximately 240 days per year. Since the coefficient of variance of the number of fishing day is 0.65, this means that the number of fishing days mostly affected the fishing effort (*i.e.* an increase of 10% on fishing days would make the effort go up by 6.5%). This is because the fishing effort of trawlers actually corresponds to the swept areas that trawlers towed, where the swept area is equal to the circumference of the mouth of the gear multiplied by the dredged line, which in turn is equal to the speed of vessel multiplied by the towed time. More particularly, this implies that the fishing effort of trawlers is equal to the circumference multiplied by the vessel speed multiplied by the dredge time. Thus, the gear or the circumference of the mouth of the gear leads to the variance which could have a second effect on the trawler's effort.

**Key economic efficiency indicators**

Among the input indicators, the average variable costs of trawlers in Nha Trang which was 361.2 million VND in 2011, is lower than that of offshore gill net fleets in 2009 which was 604.4 million VND (Duy, 2010) and that of offshore long liners in 2008 at 460.7 million VND (Long *et al.*, 2008). This is because trawlers often undertake shorter trips and operate in nearshore fishing grounds, thus, fuel cost which accounts for a huge part of the variable costs could comprise an average of 76% of the total variable costs. While gill nets and long liners spend more fishing days, 230 and 245 days with capacities more power than trawlers at 250 Hp and 126 Hp, respectively, their operating cost is usually higher than that of trawlers.

The output indicators of trawlers had on average positive values, which is quite surprising in an open-access fisheries regime. However, this result was also true with the case of tuna offshore long liners in Khanh Hoa in 2004 (Long *et al.*, 2008) and offshore gill nets in Nha Trang in 2004 and 2005 (Kim Anh *et al.*, 2006). Nevertheless, such findings could have been influenced by a number of factors. First, the indicators varied greatly, for example the net profit ranged from –57.5 to 197.5 million VND with the corresponding standard deviation at 49.2 million VND which was also high. Moreover, the standard deviation of the net profit (49.2 million VND) was approximately equal to its mean value (55.5 million VND) which is an unusual case as the values of the standard deviations should be about twice as the respective average values, as in the cases of the income, gross value added, and gross cash flow. From this data, it can be concluded that some trawlers had good efficiency records with savings on fishing costs but others could have suffered massive losses due to high costs and low earnings. Secondly, the mesh size at the cod-end of local trawlers in Nha Trang is so small at an average of 16.7 mm and varied from 12 to 25 mm, which is much smaller than the mesh size indicated in the fisheries regulations, which is 28 mm. In this regard, local trawlers could catch more small fish, juveniles, trash fish, and by-catch. Therefore, from the economic point of view, gear with smaller mesh size can catch more fish and get higher yield while the gross revenues (or fishers' profit) are increased, as a consequence.

However, as pointed out by Chien *et al.* (2009), unregulated mesh size operating in an open-access fisheries regime can only get profit on a short run and is unsustainable. These unregulated mesh sizes in trawl fisheries are causing real problems for policy makers. Furthermore, the average gross profit margin and average profit margin at 16.6% and 12.8%, respectively, imply that trawl owners in Nha Trang manage their financial resources very well (*e.g.* fishing expenses including depreciation, interest loan payment). However, three of the sampled trawlers showed negative chances of recovering their operating costs (variable costs, fixed costs and labors costs) with gross cash flow which was negative. These three vessels belong to the small group (Hp<60) which had also the lowest average gross cash flow and average net profit.

Another interesting result from the study is on vessels which are over 90 Hp (bigger group) or vessels with varying powers from 60 to 90 Hp (medium group) but spend the same fishing days. The values of the economic indicators of these two groups indicated that the bigger group had average gross revenue (915.5 million VND) higher than the medium group (758.3 million VND), but also incurring higher variable and fixed costs as well (491.3 and 67.2 million, respectively) compared with 345.3 and 54 million VND, respectively for the medium group. As a result, the profit (104 million VND) and net profit (52.9 million VND) of the bigger group were less than those of the medium group (119 and 82.8 million VND, respectively). This implies that in the case of trawl fleets in Nha Trang, bigger vessels may catch but may be not more efficient than the medium-sized vessels. Therefore, over-investment particularly on big trawlers could lead to economic inefficiency in trawl fisheries in Nha Trang. Moreover, the variable costs also varied greatly among the vessel groups, at 283.4, 345.3 and 491.3 million VND for the smaller, medium and bigger groups, respectively. Furthermore, bigger vessels often undertake longer trips incurring higher variable costs.

## Conclusion

Using the basic economic performance indicators, the economic efficiency of trawl fisheries in Vietnam was measured and evaluated in 2011 taking into account the trawl fleets in Nha Trang City, Khanh Hoa Province where 57 trawlers were surveyed to collect information of costs and earnings. The results showed that trawlers in Nha Trang are heterogeneous in terms of their technical and operational characteristics as well as in their cost and capital structures. In terms of the technical characteristics (engine power, length and width of hull), trawlers are smaller than the gill netters and long liners (Long *et al.*, 2008; Duy *et al.*, 2010). The operational information of the trawl fleets including their costs and earnings structures also varied greatly. Generally, the trawl fleets achieved high economic performance in 2011, especially in terms of economic efficiency, which is very close to the expected findings based on fisheries economic theories. This could imply that trawl fisheries in Nha Trang could be forecasted to continue expanding and attracting more investors in the future. However, the use of unregulated mesh size and destructive trawls could lead to the unsustainable development of the fisheries and overexploitation of the resources (Pomeroy *et al*., 2008; Chien *et al*., 2009).

An interesting trend was noted from the medium-sized trawlers ($60 \leq Hp < 90$) which appeared to be most efficient. Since high operating costs could lead to the efficiency of bigger trawlers, therefore, over-investment in these particular trawlers should be avoided as this could only lead to inefficiency, as in the case of Nha Trang trawl fisheries. Furthermore, the econometric results also illustrated that the number of fishing days was the strongest factor which affect the efficiency of trawl fleets in Nha Trang, with the engine power and circumference of the net-mouth having significant effects on the fishing effort.

From fisheries management points of view, assessment of the economic efficiency of trawl fleets could be considered as a key element in the sustainable development and management of fisheries. From the results of this study, policy implications on fisheries management have emerged which need special attention. First, since it is not the high investment that achieves high efficiency in trawl fisheries, therefore, the Government should undertake further investigations before making decisions on whether to invest or subsidize these fishing activities considering that over-investment could lead to inefficient operations as in case of the trawl fleets. Secondly, the use of unregulated mesh sizes leads to resources over-exploitation, marine resources destruction, increased catch of juveniles, and increased conflicts between trawlers and other gear types. Therefore, it is becoming necessary that the Government and more particularly the local authorities, should manage, test, monitor, and restrict fishing operations using illegal mesh sizes as well as destructive fishing gears.

Although this study established interesting results using only the 2011 data, the overall economic efficiency of trawl fleets remains difficult to determine. Thus, further research studies should be pursued to collect more data and create cross sectional as well as time series data, including socio-economic information of the local communities. Simultaneously, future studies should use stronger analysis methods such as the data envelopment analysis (DEA) and the stochastic frontier production function (SFPF) to compare the results and provide more exact suggestions.

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