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Calculation of Investment Costs of Turkish Anchovy Purse Seiners Operated in the Black Sea

Karadeniz'de Hamsi Avcılığı Yapan Türk Gırgır Teknelerinin Yatırım Maliyetlerinin Hesaplanması

A.Cemal Dinçer, Ercan Köse and H.Fehmi Durukanoğlu

Karadeniz Technical University, Faculty of Marine Science
61530, Çamburnu, Sürmene, Trabzon, Turkey.

Abstract

This paper presents a simple and practical method of obtaining the estimate of total investment costs for Turkish anchovy purse-seiners, designed by "traditional methods". It is intended as a guide to fishing vessel designers, builders, owners and others concerned at the beginning of a new project who may wish to know the investment, and how it changes with alterations to principal design variables, such as main dimensions, and power. The method does not supplant more refined techniques used for professional cost estimators at later stages in the design, but it may be useful in circumstances where cost estimating expertise or actual shipyard costs are not immediately available. Fishing vessels discussed in this study are of 20 to 40m long with an engine power of 300 to 1100 HP. It has been found that for the year 1997 total investment costs varied in the range from US$ 265000 to 532000, with an average value of US$ 391000. The average values for the proportions of investment cost components were found to be 25% for vessel production, 27% for machinery, and 48% for fishing gear and equipment cost.

Key words: Investment costs, fishing vessels, Black Sea, anchovy

Introduction

The Turkish fishing fleet has expanded fairly steadily over the last two decades. This expansion has taken place not only in the number of fishing vessels but also in the sizes along with the increase of main engine power units. This was mainly due to Turkish governmental policy to increase the fishing effort, implemented in 1983. In this policy, credits with rather low interest rates were granted to fishermen and custom duties were freed on the imported fishing equipment of all kinds (Anon., 1989). The number of fishing vessels was 6764 in 1980, with an increase of 2.8% it reached 8646 in 1993. The distribution of Turkish fishing vessels by operating types is as follows: 5.5% of the total number is trawler, 4.9% is purse-seiner, 2.6% is carrier boats, and 87% is of other various types. A vast majority (81.9%) of Turkish fishing vessels are in the range of 5 to 10 m. lengths. Meanwhile, 3.1% of the total is under 5 m. long, 10.9% of the total is between 10 to 20 m long. Fishing vessels with sizes 20 m. or over account for 4.1% of the total number (Anon., 1980-1993).

Purse-seiners engaged in anchovy fishing are commonly 20 to 40 m. long, and powered by main diesel engines of 300 to 1100 HP (Çelikkale, 1991). The main shipyards where the majority of Turkish purse seiners are built are located on the eastern Black Sea coast, namely in Sürmene town, which is 45 km from the central city of Trabzon. In these shipyards fishing vessels are constructed according to traditional design methods learned from historical experience and skill gained over many years. The design concept is applied by expert people trained by practice, no naval architectural and engineering skill being involved. A representative picture, possibly taken from a magazine, or an oral description given by the owner is generally enough for the shipyard to build the vessel. The owner, in most cases, supplies the builder only with the overall length (L) of the vessel what he wishes to have. Other main dimensions such as beam (B), depth (D) and draught are estimated on the basis of length (Dinçer, 1992). Powering and equipping of the vessel are entirely as a matter of preference by the owner.

Some literature is available about Turkish fishing vessels. Kafalı (1980) studied on the hull forms of the Black Sea fishing vessels and outlined the weaknesses of traditional design from the hydrodynamic point of view. Baykal (1980) suggested a regressional method that computes the hydrodynamic resistance for Turkish fishing vessels, with an accuracy of about 2%. There are also some other publications (Kafalı, 1988; Durgun, 1989; Kara, 1992; Dinçer, 1996) concerning the preliminary design of fishing vessels.

Purse seiners are only the tools to exploit anchovy stocks in the Black Sea coasts, and are found to be the most expensive type of fishing vessels in terms of investment. Considering the attitude of Turkish fishermen towards the increase of vessel sizes and the fishing effort, it can be said that investment of this kind becomes an even more important task and should be regarded with special care. Investment on fishing vessels, like any other investments, represents utilisation of economic resources which need to be carefully evaluated before actual commitment. The investment cost of a fishing vessel is an important variable determining the economics of a fishing unit. It is usually the major cost item appearing in the cash flow analysis. Since most of the operating cost items, as well as the operating revenues, tend to be very much related to the investment cost a careful estimate of this cost forms the basis for good vessel investment analysis. The cost of a fishing vessel is a function of different kinds of variables, such as technical, physical, managerial, financial and its complete estimation requires professional guidance from a range of disciplines, some of which are naval architecture, economics, cost accountancy, shipyard management, and many others (Carreyette, 1977). When dealing with the vessel investment cost of any kind, it is the usual practice to make a breakdown of the various cost elements which are included in the total cost of the vessel (Benford, 1957; Benford, 1958, and Watson, 1977).

In this study, it is not proposed to elaborate on these factors, since the objective of this paper is nothing more than a first approximation for investment cost which can be obtained fairly quickly and used practically for preliminary purposes for the fishing vessels under consideration. In accordance with this, it is aimed to relate a few important design variables to the total vessel investment cost and try to understand their interaction.

Materials and Methods

This paper deals with the investment cost estimation of Turkish purse seiners, which are traditionally built and engaged in anchovy fishing in the Black Sea. The term of investment cost (IC) was considered to be how much money the vessel-owner will pay for the vessel, fishing gear and equipment contained in the completed vessel and the miscellaneous (10%),i.e., it is the amount of money to be paid by the owner for the vessel which is fully equipped and ready for anchovy fishing, with only the exception of consumables.

The data used in this study were obtained from various interviews with the local fishing vessel owners and shipyards. Data referring to the prices used throughout the study belong to the year 1997. Information concerning prices of material, engine, and fishing gear and equipment was based on the average values taken from the market and the manufacturers' catalogues. The values of proportions for cost breakdown units such as machinery, hull construction material, and deck equipment were evaluated on the basis of information obtained from the Trabzon Fishermen Co-operative by personal communication. Since prices in Turkey are subject to continuous changes due to the high rate of inflation all the costs are expressed in US$ to maintain the validity.

There are no fixed standards for the breakdown of investment cost. For fishing vessels, it was thought to be convenient that the breakdown should include vessel production cost (VPC), machinery cost (MC), and fishing gear and equipment cost (FGEC), each of which then was sub-divided into various components as shown in Figure 1.

Vessel Production Cost

Vessel production cost (VPC) was sub-divided into hull construction cost (HCC), outfitting cost (OC), piping system cost (PSC), electric cost (EC), and painting cost (PC). Hull construction cost was assumed to be the fundamental base on which other cost components were proportionally computed from. On the information obtained from local fishing vessel owners and shipyards, it was found that OC, PSC, EC, and PC, as an average, can be taken to be proportional to HCC by the ratios of 12%, 4%, 9%, and 12%, respectively.

Calculation of HCC was made according to vessel size. For cost purposes, vessel size is best calculated on a volume measure and the method most used is cubic number (Fyson, 1985; Hamlin, 1990). Cubic number (N) is defined by length multiplied by beam multiplied by depth of the vessel (N=LxBxD), where, L is the overall length of the hull, B is the maximum overall beam, and D is the vertical distance from the top of the deck at side to the keel.

Hull construction cost was assumed to consist of material cost (MATC) and labour cost (LABC). The builder's profit margin is included in the labour cost. Turkish fishing vessel builders estimate the labour cost on the basis of material cost. They, most commonly, take the labour cost to be equal to the material cost.

Material cost (MATC) was estimated on the basis of steel weight (W_s). It is the multiplication of steel weight by the unit price of steel (C_s), which was taken to be US$357/ton as average. In literature (Watson, 1962; Sato, 1967; Fisher, 1974), several numerals which are obtained from the main dimensions of the vessel such as, length (L), beam (B), depth (D), draught

(T) have been suggested as a basis for calculations of steel weight. For preliminary cost estimation, a simplified assumption is made that the steel weight is proportional to the cubic number. Various empirical formulae based on cubic number are available for fishing vessels to estimate the steel weight (Kafalı, 1988; Grubisic and Zanic, 1988). The steel weight was similarly computed from the regression equation (W_s=0.0367$L^{2.289}$, R^2=0.988), derived for Turkish purse seine vessels (Dinçer, 1996). It was based on length rather than cubic number. The reason for using length instead of cubic number was the fact that fishermen, builders and non-scientific people are more familiar with length than cubic number. However, length can be converted into cubic number, if desirable, by means of the proportional ratios of main dimensions. Steel weight was used in this study for the entire hull structure, superstructure, and foundations for machinery and other equipment. It does not include steel in masts, booms and other steel items included in the outfit weight.

Machinery Cost

Machinery cost (MC) was arbitrarily broken down into four components: main engine cost (MEC), auxiliaries cost (AUXC), stern gear cost (SGC), and deck machinery cost (DMC). The other components of machinery cost were estimated on the basis of main engine cost. The cost components of auxiliaries, stern gear, deck machinery were assumed to be directly proportional to the MEC by the ratios of 13%, 20%, and 31%, respectively (Fyson, 1985). Main engine cost was calculated as total installed horse power (HP) multiplied by unit cost of main engine (C_{hp}). Fishing vessels under investigation were all powered by diesel engines, ranging from 300 to 1100 HP. For this power range of marine engines the average unit cost, based on the information obtained from engine manufacturers, was evaluated to be US$ 85/HP. On the basis of statistical information obtained from Turkish vessel owners and fishermen, AUXC, SGC, and DMC were estimated to be 13%, 20%, and 31% of machinery cost, respectively.

Fishing Gear and Equipment Cost

Fishing gear and equipment cost (FGEC) was considered to be composed of fishing gear cost (FGC), navigational equipment cost (NEC), fish finding equipment cost (FFEC), and skiff cost (SC).

Although fishing gear and equipment cost is a variable, which mostly depends upon the choice of the owner and the requirements of the fishing method applied, it has been observed that anchovy seiners use almost standard size of net and skiff, and the variations in instrumentation cost was not significant. Therefore, fishing gear and equipment cost was assumed to be constant and evaluated on the basis of a typical anchovy seiner such that FGC=US$ 115000, NEC=US$ 7140, FFC=US$ 13100, SC=US$ 30000.

Results

The investment cost equation has been derived for Turkish anchovy purse seiners, which are built by traditional methods, at local shipyards along the Black Sea cost. Although there are many various factors affecting the investment cost of a fishing vessel, length and engine power have been found to be the most significant design variables. The form of the equation is as follows:

$$IC=39.27L^{2.289}+153.34HP+181764$$

Where IC is the total investment cost in US$, L is the overall length of the vessel in meters, and HP is the total engine power in horse power. It should be emphasised that the validity of this equation is restricted within m. and $250 \leq HP \leq 1100$. The methodology used to assess the minimum, maximum, and average values for investment cost and its components was demonstrated in Table1. Some conclusions derived from the analysis of the investment cost equation may be as follows: The first term of the cost equation represents the vessel production cost (VPC). It was expressed as being a function of vessel length. It was found that vessel production cost varies from a minimum of 9.6% to a maximum of 44.5% of the investment cost. The average value of VPC was 25.2 % of IC. The second term of the equation corresponds to machinery cost (MC). It was directly related to main engine power. It was determined that the value of MC may be in the range of 11.2% to 43.5% of IC, with an average of 26.9% of IC. A large proportion (approximately 61%) of machinery cost was the main engine. The third term of the equation is fishing gear and equipment cost (FGEC). It was assumed to be independent of vessel size, and came out to be the largest component of investment cost. Its minimum, maximum and average values were found to be 34.1%, 68.6%, and 47.9% of IC respectively.

The variation of investment cost in relation to length and power of the vessel is presented in Figure 2 and Figure 3, respectively. Since the IC equation is a function of two independent variables, in each figure one of these variables was kept constant within the defining ranges. For HP=constant (Figure 2) the nature of the IC function is curvy linear. The curvature of the function is more apparent in the range for $20 \leq L \leq 30$m, above this range ($20 \leq L \leq 30$m) it tends to decrease, and thus IC becomes almost linear. For L=constant (Figure 3) the relationship between the IC and power is linear, and the slope of the cost line ($\Delta IC/\Delta HP$) is about 16%.

Discussion

For some years, research and preliminary design groups in profession other than naval architecture have needed a simple, reasonably accurate parametric method of developing the investment cost of fishing vessels. Turkish fishery investors are required by the governmental authorities to have feasibility reports prepared in order to apply for investment credit from the Agricultural Bank of the Turkish State. Investment cost is the essential element included in the cash flow analysis and the feasibility report. It is therefore necessary to have an idea about investment cost before undertaking the investment. There is no exact information on the IC of Turkish fishing vessels operated in the Black Sea, since they are designed traditionally, not on the basis of naval architectural project, from which a better and more accurate cost estimate can be made. The method presented in this study aims to satisfy such a need.

Investment cost may also be expressed in terms of cubic number (N), which is by far the best parameter for a fishing vessel's size, and allows cost comparison to be made between the vessels of different size, but similar shape. However, length fails on two accounts. If two vessels have the same length but proportions of the main dimensions differ, then they will be of different size and not comparable functionally. Secondly, a vessel's displacement, and its cost and capacity varies approximately as the length is cubed (Hamlin, 1990). Using the proportions of main dimensions for Turkish fishing vessels under investigation (L/B=3.33, L/D=9) and from the definition of cubic number (N), vessel length (L) can be expressed in terms of cubic number ($L=3.1176N^{1/3}$). Substituting L in the cost equation results,

$$IC=530.17N^{0.763}+153.34HP+181764$$

Where N is the cubic number of the vessel in m^3. Expressing IC in terms of N, rather than L, has an advantage that it allows cost comparisons to be made between fishing vessels of even dissimilar types and may be used more commonly.

Vessel production costs of Turkish fishing vessels have been found to be relatively low in comparison to that of European vessels (Eyres, 1984). This may be attributed to cheaper labour in Turkey. Labour cost is generally low in Turkish fishing shipyards. Because, the shipyards do not employ such high qualified and skilled people as naval engineers and experts. Machinery cost has been found rather high in comparison to similar vessels of other country (Özdamar, 1995). The main reason for this is the attitude of Turkish fishing vessel owners, the use of unnecessarily high power, and getting into unusually high competition. Since the fishing vessels are not powered according to naval architectural rules the power chosen becomes, in most cases, higher than required. Main engine cost is the highest cost component of machinery cost, which amounts to 61%, on average. Therefore, powering the vessel is one of the most important tasks of the design and should be made by naval architects. Reducing the power to the required level may result in considerable saving in MC, and thus total investment cost. FGEC is the highest component of IC, which is made up by FGC of 69.1%, NEC of 4.3%, FFEC of 7.9% and SC of 18.2% for a typical anchovy seiner. The cost saving in FGEC may be achieved by reducing the ratios of these components, particularly the FGC, which is the major one, but the possibility of reducing FGC is low, because it is directly proportional to size of the net, which is almost of standard size for Turkish anchovy seiners. The size of net is generally restricted by the requirements of purse seining method and the fish species aimed to be caught (Fridman, 1988). Skiffs are of standard size as well. NEC and FFEC are only a small fraction of FGEC, in relation to the other components. It may, therefore, be concluded that it is not possible to obtain an important saving in IC by the alteration of FGEC.

There is recently a tendency among the Turkish fishing vessel owners to regard the auxiliary system, such as the hydraulic system, the pumping system and possibly refrigeration, as being of more importance than it was before. This may be due to the increased demand for auxiliaries because of increased fishing effort and need for higher technology. There are differences of opinion between fishing vessel owners about lifting and hauling gear for the nets. The wide variety of arrangements to be seen on fishing vessels is evidence to this, and the conclusion to be drawn is that the arrangements are rarely satisfactory (Pike, 1988). There are various types and ranges of fish finding devices. The general trend of Turkish fishermen is the acceptance of more sophisticated and expensive instruments. This attitude may be explained by the requirement of fishing method, which depends upon instrumentation almost completely. The purse seining, where enormous investment in nets and mechanical handling methods are made, requires accurate fish finding.

It should be emphasised that for preliminary costing purposes we have to be content with approximations and the average values for the parameters used for deriving the cost equation. Their accurate enumeration could only result from analysis of updated information.

Özet

Bu çalışmada, geleneksel yöntemlerle dizayn edilen Türk hamsi gırgır teknelerinin toplam yatırım maliyetini hesaplamaya yönelik pratik ve sade bir yöntem önerilmiştir. Çalışmanın esas amacı; balıkçı tekneleri tasarımcılarına, yapımcılara ve balıkçılık sektörüne ilk defa giriş yapacak olan diğer ilgililere yatırım maliyeti ve bunun tekne ana boyutları ve makine gücüyle olan değişimi hakkında gerekli ön bilgiyi sağlamaktır. Önerilen yöntem, profesyonel maliyet hesaplayıcılarının tasarımın son evrelerinde kullandıkları daha duyarlı ve karmaşık tekniklerin yerine geçmemesine rağmen ön hesaplamalar için oldukça yararlıdır. Çalışmada konu edilen balıkçı teknelerinin boyları 20-40 m arasında ve motor güçleri ise 300-1100 HP aralığında değişmektedir. Söz konusu balıkçı gemilerinin toplam yatırım maliyetlerinin 1997 yılı için 265000-532000 US$ arasında değiştiği ve ortalama değerinin 391000 US$ olduğu belirlenmiştir. Toplam maliyeti oluşturan bileşenlerin ortalama değerlerinin; tekne maliyeti için %25, makine maliyeti için %27 ve av araç ekipmanları için %48 olduğu belirlenmiştir.

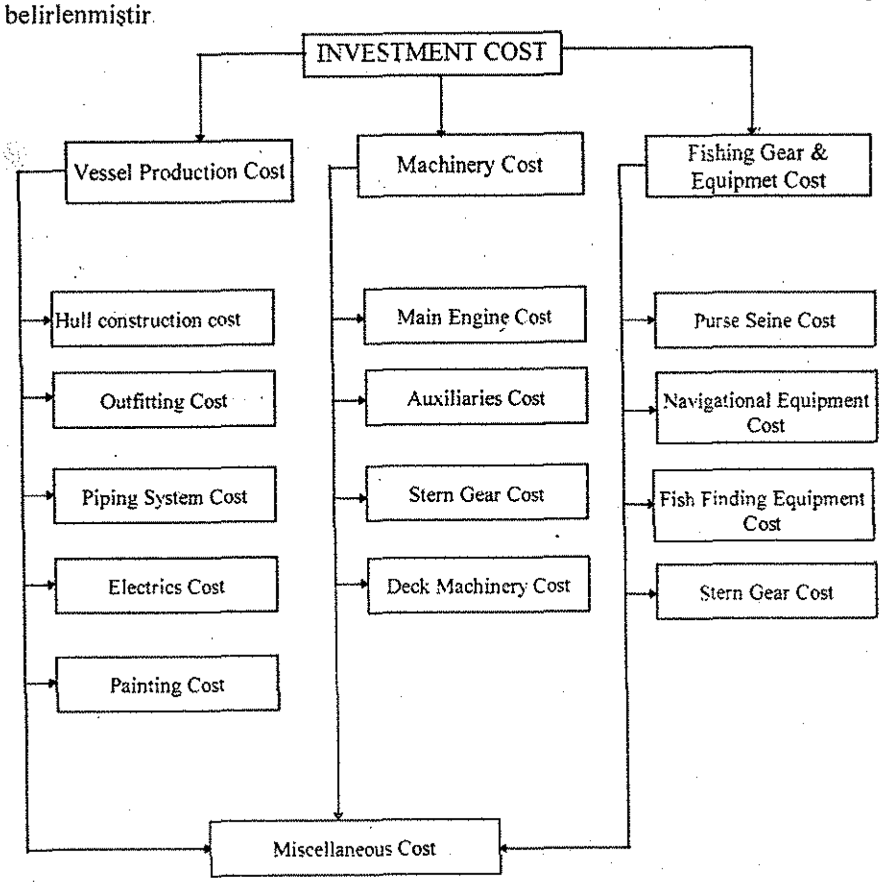

Fig. 1. The components of investment cost.

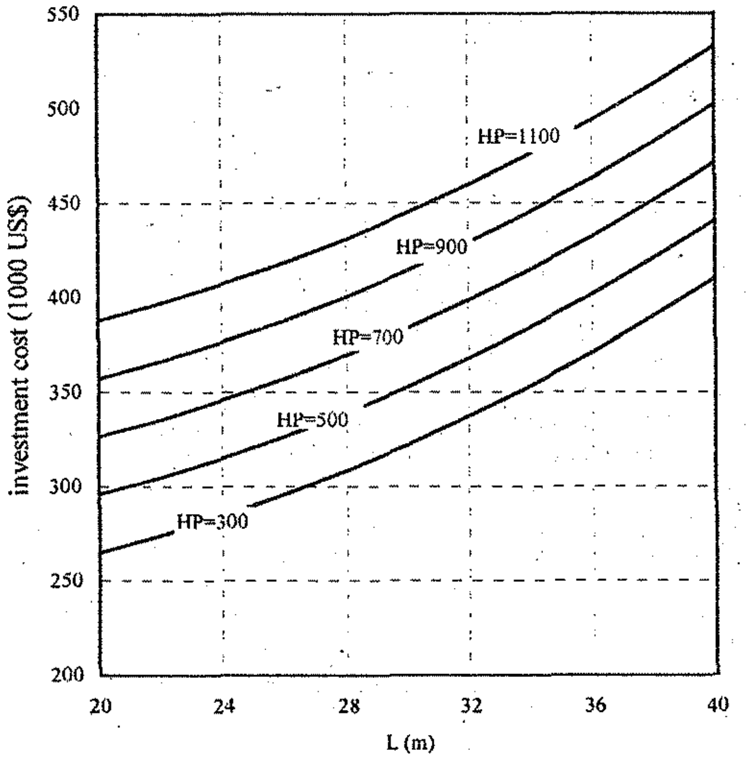

Fig. 2. Variation of IC in relation to vessel length (HP = constant).

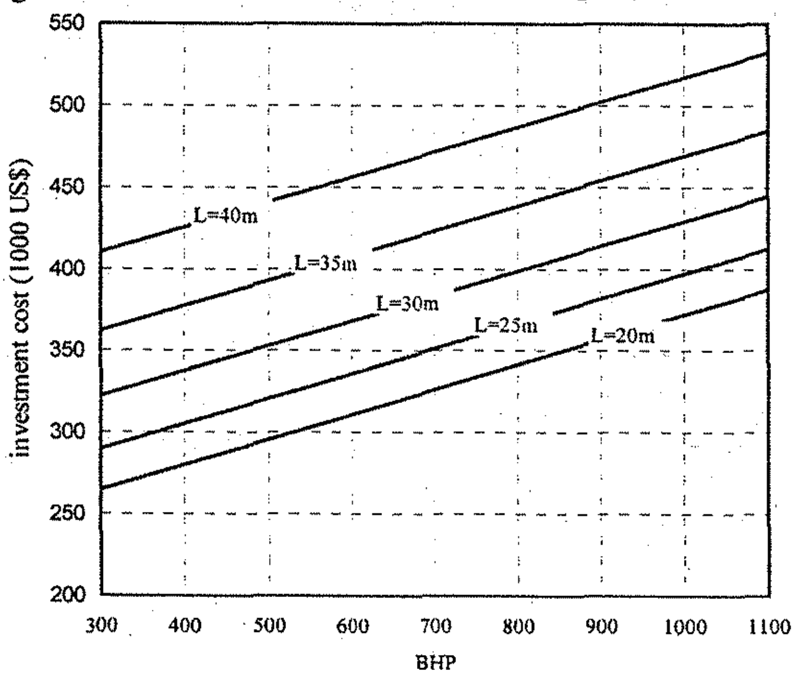

Fig. 3. Variation of IC in relation to vessel power (L = constant).

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