

Economic Analysis Of A Research Vessel: Case Study On The Black Sea

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Abstract:

Background: *This paper presents an economic analysis of a research vessels from the Black Sea. A research ship in the Black Sea refers to a ship created, modified or equipped to carry out research in the Black Sea. These research ships (RV or R/V) perform a variety of functions depending on the missions they have to perform in the Black Sea. Hence, a research vessel can perform a number of duties, while other ships can only deal with one or two such activities, depending on their mission.*

These research vessels are designed and built to withstand the harshest environmental conditions, such as dangerous storms in the Black Sea.

A research ship can support a variety of marine environments in a variety of ways from the Black Sea.

Key Word: *research, vessel, theorem, distribution, equipment.*

Date of Submission: 09-10-2023

Date of acceptance: 19-10-2023

I. Introduction

Black Sea lies between two continents: Europe and Asia. That is to say, to the east of the Balkans, to the south of the Eastern European Plain, to the west of the Caucasus and to north of Anatolia.

Moreover, the Black Sea borders the following countries: Romania, Bulgaria, Turkey, Ukraine, Georgia and Russia, [1].

Black Sea covers 436,400 km² (without the Sea of Azov), has a maximum depth of 2,212m and a volume of 547,000 km³.



Fig. 1. Free map of Black Sea

In the Black Sea, are operating many various types of ships: container ships, research vessels, bulk carriers, tanker ships, passenger ships, naval ships, offshore ships, and special purpose ships, as well Fig. 2.

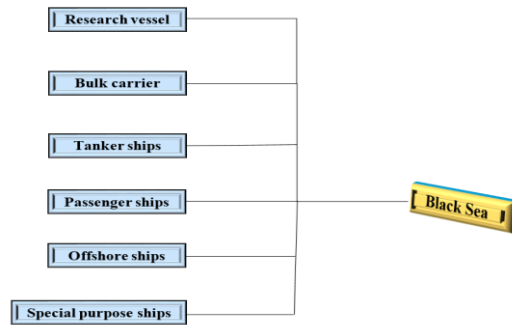


Fig. 2. Types of ships in the Black Sea

The main activities of the Black Sea are: navigation, fishing, tourism and hydrocarbon exploration, Fig. 3.

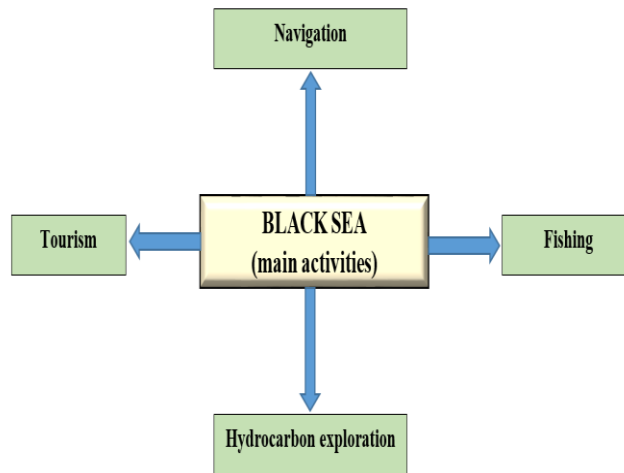


Fig. 3. Activities of the Black Sea

II. Efficiency of the research vessel

The research vessel are highly advanced mobile (research) stations. Besides, these ships that provide stable platforms from which explores can: deploy special equipment, divers and submersible, [2].

The modern types of research vessels which operate in the Black Sea are: fisheries research, naval research, oil exploration and hydrographic survey, Fig. 4.

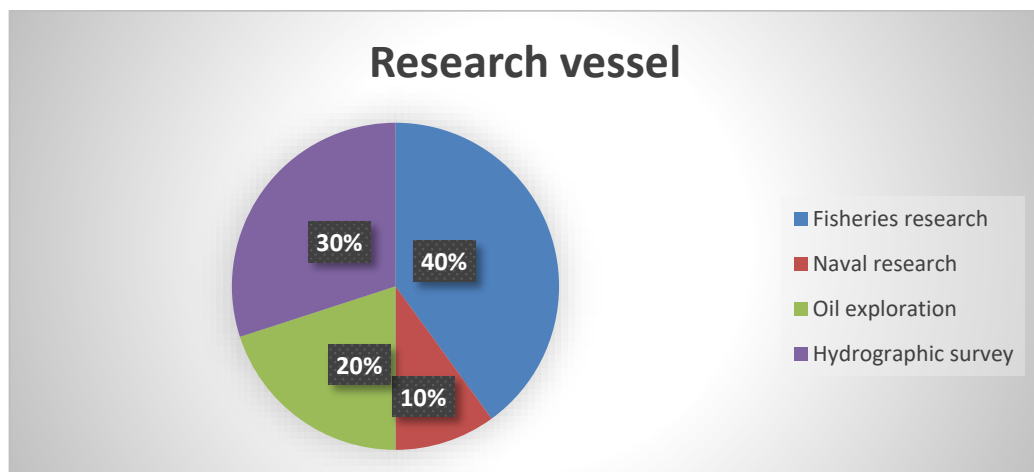


Fig. 4. Situation of research vessel in the Black Sea

The attributes of the four types of ships, [3]:

- Fisheries research vessels → requires platforms capable of performing various operations: to tow different types of fishing nets, collect plankton or water samples from a wide range of depths and carry special acoustic fish-finding equipment.
- Naval research vessels → investigate naval concerns such as: sea mines, detecting submarines, testing sonar and weapons on board.
- Ships for oil exploration → the vessels are moved from one area to another as needed to drill into the seabed and find out what deposits lie beneath it.
- Hydrographic survey ships → the vessels designed to conduct hydrographic research and survey.



Fig. 5. Research vessel in mission

The most common specific installations of a research vessel are, according to Fig. 5:

- Aft crane → is a type of machine on the stern, generally equipped with a hoist rope, wire ropes, chains and sheaves.
- Winches → a mechanism used to reel in, to let out, or otherwise adjust the tension of a: rope, wire, or cable.
- Stern A-frame → a lifting gear often installed on stern of cable vessels, for subsea load handling.

Probabilities, statistics and statistical analysis are used in a variety of researches, which can be performed in various fields, such as for example in [2].

In order to study the dangers on a research ship, an important step is to use the concept of conditional probability, [4], which is based on the Bayes' Theorem.

For this purpose, we introduce the Bayes' Theorem which has the equation:

$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)} \quad (1)$$

Where:

- A and B → events.
- P(A) → probability of observing A without any given conditions.
- P(B) → probability of observing B without any given conditions.
- P(A|B) → how often A happens given B happens.
- P(B|A) → how often B happens given A happens.

Thereby, during the explanation there may be the following cases:

- P(fire) = 1%, if dangerous fires are rare.
- P(smoke) = 20%, if smoke is fairly common due to diesel engine.
- P(smoke|fire) = 80% of dangerous fires make smoke.

We can then discover at the research vessel, the probability of a dangerous fire when there is smoke:

$$P(\text{fire}|\text{smoke}) = \frac{P(\text{smoke}|\text{fire}) \cdot P(\text{fire})}{P(\text{smoke})} \quad (2)$$

And

$$P(\text{fire}|\text{smoke}) = \frac{80\% \cdot 1\%}{20\%} = 4\% \quad (3)$$

So, it is still worth checking for any smoke on the research ship because any crew does not want to have fires on board.

Another important probability distribution to be used in the economic analysis of a research ship is the Poisson distribution, [5].

The relationship which gives the Poisson distribution is:

$$P(X = k) = \frac{\lambda^k \cdot e^{-\lambda}}{k!} \tag{4}$$

Where:

- ✦ $k \rightarrow$ the number of occurrences.
- ✦ $e \rightarrow$ Euler's number ($e = 2.7182818\dots$).
- ✦ $X \rightarrow$ a discrete random variable.
- ✦ $\lambda \rightarrow$ the average rate of success ($\lambda > 0$).

Captain of a research ship can use the Poisson distribution to model the number of the Black Sea missions in a month, [6].

For example, suppose a certain ship in the Black Sea has an average of four research missions per month. Because the average event rate is one mission per one month, $\lambda = 2$, [7].

Table no 1: Values of Poisson distribution

Parameter	Value
P(X=5)	0.0361
P(X=6)	0.0120
P(X=7)	0.0034
P(X=8)	0.0009

Further on, it is shown a graphic representing the impact of Poisson distribution on the economic analysis of the research ships, Fig. 5.

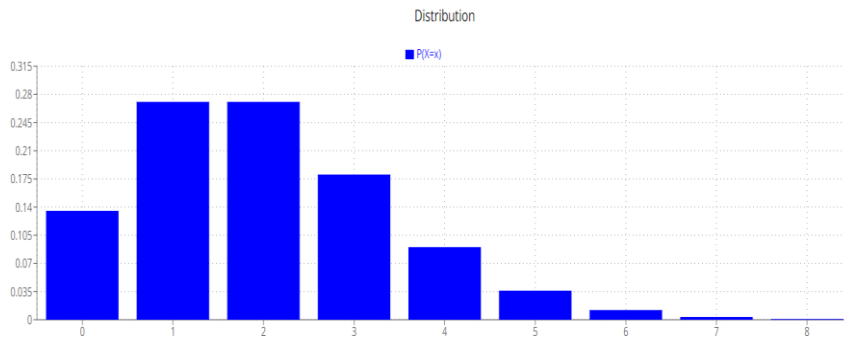


Fig. 5. Graphic of Poisson distribution

Frequency of research ships collisions in the Black Sea is a simple multiplication of the components with the relation, [8]:

$$F_{CP} = P_1 \cdot P_2 \cdot P_3 \cdot F_d \cdot N \tag{5}$$

Where:

- ✦ F_{CP} – frequency of researcher ships collisions in the Black Sea.
- ✦ P_1 – probability that the passage planning stage of the mission is not carried out correctly.
- ✦ P_2 – probability that the research ship suffers a watch keeping failure.
- ✦ P_3 – probability that the research vessel fails to alert the ship in time to prevent a collision.
- ✦ F_d – proportion of research ships that are in the Black Sea.
- ✦ N – total traffic of research ships in the Black Sea.

III. Acknowledgement

We would like to acknowledge Prof. Costel Stanca, Dean, Faculty of Navigation and Naval Transport, Constanta Maritime University of Romania for his assistance by providing research instruments.

IV. Conclusion

An important advantage of a research ship is that it allows researchers to conduct their research directly in the Black Sea, rather than collecting samples and data from other sources.

Because of advances in science and technology, research vessels from the Black Sea have also grown advanced in recent years.

In addition to researchers, students can also participate in educational programs on research ships.

These students can be from universities that have various fields: maritime, military, biology, engineering, economics, etc.

The use of research vessels in the Black Sea basin enhances and expands the high-quality education and research opportunities that a university can offer. And as a leading marine science institution, a university can also provide valuable benefits for community and the associated maritime economy.

Furthermore, a new research vessel for the Black Sea, will be equipped with additional exploration devices in the future, at acceptable purchase prices.

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