Identification and Prioritization of
Preventive Measures for Encountering Piracy

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Abstract: This study is conducted in three phase due to survey some ways and measures that are considered to be useful for reduction of piracy in Aden gulf. In the first phase we studied the meaning of piracy from different point of views such as United Nations Convention on the Law of the Sea and International maritime organization, International Maritime Bureau. Next, in the second phase we delved into some measures and research subjects to face piracy in Aden gulf directly. Subsequently in the Third phase, the measures, formalized at the second stage, were prioritized by use of Analytical Hierarchy Process (AHP) and TOPSIS in terms of the Practicability, implementation costs, time needed for implementation and the efficacy in reducing piracy. Finally, as a result, by what we came on with TOPSIS Method, respectively "Retrospect on previous justice rules for sentencing sea robbers and terminating their obstacles for capturing them" was considered at the top of the measures and "Asking all countries in order to cooperate and protecting merchant ship according to accepted treaty" "Helping Somali to be powerful and dependent country for protecting its borders", "Setting an international court for sentencing sea robbers "Equipping merchant ship by LASER block sighted shooter and Setting a local communicative center" regularly have gained the most mark according to the order of.

Key words: Piracy % Somali % Aden Gulf % Prevention measures % TOPSIS % Preference

INTRODUCTION

One of the vital and critical parts of the country economic base which affect the quality and the quantity changes and undergoes the development is considered as Sea transportation. Beside that it has a wide range of importance on all production and service fields. Hence it cover huge dominant in economic activity and piracy can not be out of this issue [1-4]. Growth matter on piracy especially in Somali and Aden gulf recently disabled international trade and transportation even insurance included [5, 6]. And these actions were not without international reaction particularly as far as we can say are more intense now in order to face and stop piracy. Based on statistics these actions for reduction the piracy cost 12 billion dollar each year for countries [7, 8]. Piracy is one of the old proved danger that threat ships, people and goods [9]. This phenomenon gets alternative ups and downs during the history and considered one of the most danger threats that one day existed and another day vanished [10-12]. All believe that if the conditions are available, there is no doubt that it will occur again. Nowadays piracy cause a lot of detriments for economic and environment. New era of piracy is full of severity and bloodshed and atrocity and life menace [13]. It is scary for all those are alone and defend less [14]. No one can imagine this trouble in sea. Sea travelers should be safe enough to travel free [15].

The main concern of this study is to survey some ways and measures considered useful for reduction of piracy in Aden gulf, other minor goals are elaborated gradually as in bellow:

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- Study and clarification of piracy term from United Nations Convention on the Law of the Sea and international maritime organization and International Maritime Bureau and traditional point of views.
- Delving on research literature first and after that the study slightly moved to scrutinize the research subjects and looking for the proper ways to stop piracy in Aden gulf.
- Some extends of above mentioned preventive measures are identified according to some Criteria that considered to have a particular effects on stopping piracy and also by setting the specific time and cost for administrating these Criteria based on TOPSIS and AHP methods.

Literature Review: In the study under the title of international society analysis on pirates invader in Somali seashores and Aden gulf consequences the collapse of Somali in 1990 concluded that the international society faced problems with finding that pirates invading trademark and other ships that carry humanistic help for Somali people [14]. Influenced by these problems and terrible crisis, international Security Council organization stipulated a treaty on which pirate events and armed-robbery in Somali seashores water had made the condition worsen and ended on mutual threat on peace and international security. However these disobedience from that treaties will have its special following and sentencing the pirates with new rules how to stop these pirates that seems are more than 1982 point about sea rules. In other study which titled sea security, the term piracy defined according to different point like 101 to 1982 in international sea rules organization and survey for these ambiguities.

Three factors are considered for piracy:

- Alternativeness on religious or politic
- Geographic and land complexity
- Disequilibrium and social class differentiation

These three factors coalescence together and make the theory of triangle piracy [16].

In other study under the subject of Somali, the new paradise for pirates first [17], concern on recent invades and study the country history in this filed and finally concluded it as an unhappy one. In this study he delved into the country as an important transformational ways from the geographical and strategically point of views and

also studied the piracy and raise this question that why a safe sea way should change into the most dangerous shipping way after a decade out of the blue? Referring to people consideration and specially maritime experts, they think that these invades began with the government collapse in the early 1991, which suddenly after that foreign fishing ships start on attacking stranded ships on seashores.

Chong and Hudson [18] in the study with the following subject" piracy and relational lead detriments" cited that these detriments will only be accepted that extraordinary expenditure seems tactful and rational for ship health and goods in the maritime journey. Occasional study also provided in US maritime courts.

In Bawdan [19] study, who survey the cost on ocean piracy compared to sea piracy, said that the economic expenditure spent on ocean is further more than piracy and it has direct or indirect effect on shipping economic such as insurance cost, damage cost, path digression, cost for protecting from pirate, cost for maritime power, cost for legal looking, cost for security facility all are said to be direct costs and indirect one subdivided into three parts such as cost of local trade, cost of food price inflation, cost of foreign decrease income.

Research Methodology: This study considered as an applied one among research hence, the main concern is to delve about a special scientific field. The major concern of this study is to conduct and identify the ways of how to avoid piracy in Aden Gulf due to research classification. So this study is surveying, describing and presumption the core subject because it should be able to discuss and elaborate some aspects of wanted phenomenon and finally get the results and also considered as an analytic study because the researcher tried to analysis the relationships between dependent and independent variables, so it refers to grounding research.

Statistics Sample and Subjects: In this study subjects are concerning all the experts of ports and maritime organization, national oil Transformation Company and Islamic republic shipping and their commanders of such organization. Due to the ambiguity of the exact subject's number, statistic sample broadcasted by questionnaires between 20 persons of ports and maritime experts then from estimating the first variance in certain level 95 percent of sample 10 persons were estimated. Here, the term "research subjects" means statistic sample on which it are 100 persons.

TOPSIS Method: TOPSIS method was introduced for the first time by Yoon and Hwang and was appraised by surveyors and different operators. TOPSIS is decision making technique [20]. It is a goal based approach for finding the alternative that is closest to the ideal solution. In this method, options are graded based on ideal solution similarity [21]. If an option is more similar to an ideal solution, it has a higher grade [22]. Ideal solution is a solution that is the best from any aspect that does not exist practically and we try to approximate it. Basically, for measuring similarity of alternative (or option) to ideal level and non-ideal, we consider distance of that alternative from ideal and non-ideal solution [23].

The steps of TOPSIS method are as follow [20]:

First Step: Construct the normalized decision matrix. This step converts the various attribute dimensions into non dimensional attributes. An element rij of the normalized decision matrix R is calculated as follows: (x_{ij} is the value of i th alternative in j th criteria),

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (1)$$

Second Step: Obtain a weighted normalized decision matrix, where w_j is the weight of j th criteria. $\Sigma w_j = 1$, $W = \{w_1, w_2, ... w_n\}$

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \cdots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix}$$

Third step: Determine the positive ideal solution (V^+) and negative ideal solution (V^-).

$$V^+ = \{(\max_i V_{ij} \mid j \in j_1), (\min_i V_{ij} \mid j \in j_2) \mid i = 1,2,...,m\} \quad (2)$$

$$V^- = \{(\min_i V_{ij} \mid j \in j_1), (\max_i V_{ij} \mid j \in j_2) \mid i = 1,2,...,m\} \quad (3)$$

V^+ and V^- are the best and the worst weighted normalized values for all alternatives according to j th criterion, respectively. j_1 is the set of benefit attributes while j_2 is the set of cost attributes.

Fourth Step: In this step the Euclidean distance of each alternative from the overall ideal and negative ideal solution is determined, respectively, as follows:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} v_{ij}^+)^2}, \quad i = 1,2,...,m \quad (4)$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} v_{ij}^+)^2}, \quad i = 1,2,...,m \quad (5)$$

Fifth step: Calculate the relative closeness to the ideal solution.

$$C_i^* = \frac{s_i}{(s_i^+ + s_i)}, 0 < c_i^+ < 1, \quad i = 1,2,...,m \quad (6)$$

$$C_i^* = 1 \quad \text{if} A_i = A^+$$
$$C_i^* = 1 \quad \text{if} A_i = A \quad (7)$$

Sixth step: Rank the alternatives in descending order of c_i^* or select alternatives with maximum value of c_i^*.

Analytical Hierarchy Process: AHP is a decision-making tool that can help describe the general decision operation by decomposing a complex problem into a multi-level hierarchical structure of objectives, criteria, sub-criteria and alternatives. The top level of the hierarchy denotes the goal of the problem and the intermediate levels denote the factors of the respective upper levels. Meanwhile, the bottom level contains the alternatives or actions considered when achieving the goal [24]. AHP permits factors to be compared, with the importance of individual factors being relative to their effect on the problem solution [25]. The AHP comprises six major steps:

- Define the unstructured problem.
- Decompose the problem into a hierarchical structure.
- Employ pairwise comparisons.
- Find the maximum eigenvalues and eigenvectors in order to estimate the relative weights of the decision elements. After a comparison matrix has been formed, the priority of the element can be compared by the computation of eigenvalues and eigenvectors with the following formula, where w is the eigenvector, the weight vector, of A and λmax is the largest eigenvalue of A:

$$A. \ W = \lambda \text{maax} . \ w \quad (8)$$

- Check the consistency property of the matrix.
- Aggregate the relative priorities of the decision elements to obtain an overall rating for decision alternatives.

RESULTS

First Phase: Terms Definition: By whole we can define from three points.

UNCLOs View: Based on Article 101 ofUnited Nations Convention on the Law of the Sea (UNCLOs) Piracy consists of any of the following acts [23]:

Any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft and directed:

- On the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;
- Against a ship, aircraft, persons or property in a place outside the jurisdiction of any State;

Any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft;

- Any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b).
  - Piracy from international rules view:

International Maritime Organization View:

- There is another definition on which indicated and stated by international maritime organization, "any unlawful act of violence or detention or any act of depredation at anchor, off ports or when underway through a coastal State's territorial waters as armed robbery against ships"[23].

International Maritime Bureau View: The IMB defining the piracy as "An act of boarding or attempting to board any ship with the apparent intent to commit theft or any other crime and with the apparent intent or capability to use force in the furtherance of that act".

Seizure of a pirate ship or aircraft based on Article105 of UNCLOs, "on the high seas, or in any other place outside the jurisdiction of any State, every State may seize a pirate ship or aircraft, or a ship or aircraft taken by piracy and under the control of pirates and arrest the persons and seize the property on board. The courts of the State which carried out the seizure may decide upon the penalties to be imposed and may also determine the action to be taken with regard to the ships, aircraft or property, subject to the rights of third parties acting in good faith".

2edPhase: In this phase, first we delved on research literature and then slightly we shift the study to scrutinize the research subjects and looking forward for the proper ways in order to stop piracy in Aden gulf. Finally 22 measures for encountering piracy have been identified and presented in Table1.

Table 1: Prevention Measures for Encountering Piracy

Measures	No	Measures	No
Setting bank guards in Somali seashores	11	equipping the merchant ship with firefighting instruments which gadget by remote control	1
Setting an international court for sentencing sea robbers	12	Equipping merchant ship by LASER block sighted shooter.	2
Setting an educational course for crew in order to teach then defense methods against sea robbers	13	Equipping the merchant ship by crewless adrift	3
Issuance a specific Permission from national organization in order to send forces in particular areas which benefit the countries.	14	Equipping the merchant ship by high power flash and noise sensors	4
Collecting necessary information about piracy justice rules and present them for security councilmen	15	Equipping the merchant ship by setting a protective high voltage electrical system on it.	5
Issuance a specific permission to Ask those countries' forces in order to cooperate and protecting merchant ship.	16	Locating and avowing international touring and security area	6
Controlling fishing ships such as Chinese ones that put pressure on Somali seashore local people	17	Setting the officials and executive subjects to face sea robbers	7
Setting a local communicative center	18	Setting the special justice and rules to sentencing sea robbers	8
Insuring the security of the merchant ship by sending air forces	19	Retrospect on previous punishment rules of the sea robbers and terminating capturing obstacles by facilitating the way to sentencing sea robbers.	9
Movements of IMB for Setting maritime police stations by attracting other countries investment	20	Helping Somali to be powerful and dependent country for protecting its borders	10

Table 2: Criteria

Time	Cost	Practicability	Efficacy
0.22	0.23	0.25	0.3

Table 3: Decision matrix

	T	C	P	E
NO	time	cost	Practicability	efficacy
1	6	7	8	5.5
2	8	6	8	5
3	3	2.8	5.7	5.07
4	4	3.7	4.11	5.34
5	5	6	6.03	6.01
6	5	6	7	8
7	6	7	6.34	5.8
8	6	8	8.8	9
9	7	7.44	8.77	9
10	4	2	4.34	9
11	5	5	4	7.08
12	6	6.01	7.7	8.54
13	7	7.34	7	7.13
14	6.9	7.77	7.89	8.03
15	7	6.8	7.56	8.12
16	8	6.9	8	8.23
17	7.9	7.34	7	7.9
18	8	7.4	7	8.41
19	5	4	6.8	8
20	7	7.4	7	8.67

Table 4: normalized matrix

	T	C	P	E
NO	time	cost	Practicability	efficacy
1	0.2144	0.2476	0.2559	0.1636
2	0.2859	0.2122	0.2559	0.1487
3	0.1072	0.0990	0.1824	0.1508
4	0.1430	0.1309	0.1315	0.1588
5	0.1787	0.2122	0.1929	0.1787
6	0.1787	0.2122	0.2239	0.2379
7	0.2144	0.2476	0.2028	0.1725
8	0.2144	0.2829	0.2815	0.2677
9	0.2502	0.2631	0.2806	0.2677
10	0.1430	0.0707	0.1388	0.2677
11	0.1787	0.1768	0.1280	0.2106
12	0.2144	0.2126	0.2463	0.2540
13	0.2502	0.2596	0.2239	0.2121
14	0.2466	0.2748	0.2524	0.2388
15	0.2502	0.2405	0.2419	0.2415
16	0.2859	0.2440	0.2559	0.2448
17	0.2823	0.2596	0.2239	0.2350
18	0.2859	0.2617	0.2239	0.2501
19	0.1787	0.1415	0.2175	0.2379
20	0.2502	0.2617	0.2239	0.2579

Table 5: Weighted normalized matrix

	T	C	P	E
No	time	cost	Practicability	efficacy
1	0.0472	0.0569	0.0640	0.0491
2	0.0629	0.0488	0.0640	0.0446
3	0.0236	0.0228	0.0456	0.0452
4	0.0315	0.0301	0.0329	0.0476
5	0.0393	0.0488	0.0482	0.0536
6	0.0393	0.0488	0.0560	0.0714
7	0.0472	0.0569	0.0507	0.0518
8	0.0472	0.0651	0.0704	0.0803
9	0.0550	0.0605	0.0701	0.0803
10	0.0315	0.0163	0.0347	0.0803
11	0.0393	0.0407	0.0320	0.0632
12	0.0472	0.0489	0.0616	0.0762
13	0.0550	0.0597	0.0560	0.0636
14	0.0543	0.0632	0.0631	0.0717
15	0.0550	0.0553	0.0605	0.0725
16	0.0629	0.0561	0.0640	0.0734
17	0.0621	0.0597	0.0560	0.0705
18	0.0629	0.0602	0.0560	0.0750
19	0.0393	0.0325	0.0544	0.0714
20	0.0550	0.0602	0.0560	0.0774

Third Phase: In this phase some extends of preventive measures are identified according to some Criteria that considered have particular effects on stopping piracy and also by setting the specific time and cost for administrating these Criteria based on TOPSIS and AHP during the following steps:

First Step: In this step preventive measures for stopping piracy are classified due to dedicated time, executive cost as represented below in Table. 2.

Second Step: In this step identified measures for stopping piracy have been prioritized according to Practicability, implementation costs, time needed for implementation and the efficacy in reducing piracy Criteria.

At first by using equation 1 Decision matrix as it presented in the Table 3 has been converted to normalized decision matrix (Table 4).

And then by multiplying the weight of Criteria into normalized matrix we get the weighted normalized decision matrix. Table 5 shows the weighted normalized decision matrix.

Third Step: In this step by using number 2 and 3, we nominate ideal positive and negative solution as bellow.

$$A_{ij}^+ = (0.0629, 0.0650, 0.0703, 0.0803) \text{ Ideal positive solution}$$

$$A_{ij}^- = (0.0235, 0.0162, 0.0319, 0.0446) \text{ Ideal negative solution}$$

Table 6: final result of TOPSIS method

No	Measures	di+	di-	ci	Rank
1	equipping the merchant ship with firefighting instruments which gadget by remote control	0.0365	0.0570	0.6101	11
2	Equipping merchant ship by LASER block sighted shooter.	0.0397	0.0602	0.6025	13
3	Equipping the merchant ship by crewless adrift	0.0720	0.0151	0.1733	20
4	Equipping the merchant ship by high power flash and noise sensors	0.0685	0.0162	0.1915	19
5	Equipping the merchant ship by setting a protective high voltage electrical system on it.	0.0450	0.0406	0.4746	16
6	Locating and avowing international touring and security area	0.0333	0.0510	0.6050	12
7	Setting the officials and executive subjects to face sea robbers	0.0389	0.0511	0.5676	14
8	Setting the special justice and rules to sentencing sea robbers	0.0157	0.0754	0.8275	4
9	Retrospect on previous punishment rules of the sea robbers and terminating capturing obstacles by facilitating the way to sentencing sea robbers.	0.0091	0.0753	0.8923	1
10	Helping Somali to be powerful and dependent country for protecting its borders	0.0681	0.0367	0.3497	18
11	Setting a bank guards in Somali seashores	0.0540	0.0345	0.3894	17
12	Setting an international court for sentencing sea robbers	0.0246	0.0591	0.7064	10
13	Setting an educational course for crew in order to teach then defense methods against sea robbers	0.0240	0.0618	0.7201	9
14	Issuance a specific Permission from national organization in order to send forces in particular areas which benefit the countries.	0.0144	0.0696	0.8290	3
15	Collecting necessary information about piracy justice rules and present them for security councilmen	0.0178	0.0640	0.7824	8
16	Issuance a specific permission to Ask those countries' forces in order to cooperate and protecting merchant ship.	0.0130	0.0706	0.8449	2
17	Controlling fishing ships such as Chinese ones that put pressure on Somali seashore local people	0.0183	0.0679	0.7883	7
18	Setting a local communicative center	0.0161	0.0705	0.8143	5
19	Insuring the security of the merchant ship by sending air forces	0.0442	0.0416	0.4850	15
20	Movements of IMB for Setting maritime police stations by attracting other countries investment	0.0174	0.0676	0.7956	6

And then the Euclidean distance of each alternative from the overall ideal and negative ideal solution is determined. Finally according to relative closeness to the ideal solution the identified measures have been prioritized. Results are represented on Table 6.

CONCLUSION

Themain concern of this study is to recognize and prioritizes the preventive measures for encounteringand reducing piracy on its minimum level in Aden gulf and due to this it is conducted in three phase on which in the first one, the author directly tried to define the meaning of piracy from different point of views such as international maritime rules and traditional one, next in the second phase with surveying the research literature and setting brainstorm with subjects we tried to act and identify the preventive measures in advance, finally in the third phase we put these measures into the selected modelof TOPSIS and due to time and cost implementation were classified by their importance and marks, then the revealed Result from the related impact of measures Criteria, "Retrospect on previous punishment rules of the sea robbers and terminating capturing obstacles by facilitating the way to sentencing sea robbers" "Helping Somali to be powerful and dependent country for protecting its borders" "Setting an international court for sentencing sea robbers" have gained the most mark and from the cost view Setting an international court for sentencing sea robbers get the most mark and from the time view 'Equipping the merchant ship by setting a protective high voltage electrical system on it" and "Setting a local communicative center have the most mark" regularly.

Finally, based on TOPSIS Method, the measures as a result ought to be such as "Retrospect on previous punishment rules of the sea robbers and terminating capturing obstacles by facilitating the way to sentencing sea robbers" "Helping Somali to be powerful and dependent country for protecting its borders" "Setting an international court for sentencing sea robbers" have gained the most mark, "Setting an international court for sentencing sea robbers" and "Equipping the merchant ship by setting a protective high voltage electrical system on it" and "Setting a local communicative center" regularly have the most mark according to their mentioned order.

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