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Research Article

### ANALYSIS OF MARITIME PIRACY BY USING QUALITATIVE METHODS

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#### ABSTRACT

Nearly 90% of world trade is transported by sea. Maritime piracy is a major threat for maritime security, shippers, crews, cargo owners and insurance companies. Main reasons of piracy and armed robbery attacks, piracy statistics, international conventions, regulation and multinational efforts were examined and maritime piracy against ships are analyzed in the period 2015 to 2020 in the study. The Chi Square Test ( $\chi^2$ ) was used to test statistical relationship between categorical variables such as piracy attacks by years, months and hours, types, regions and type of vessels attacked. The results of the frequency distributions show that the most piracy attacks occurred in 2015 (20.9%), the most attacks were in March-April-May (30.2%), the most attacks were occurred between the hours 24:00-04:00 (29.2%) the most attacks occurred in South East Asia (42.6%), the most type of attacks against to ships were boarded (79.1%), the most attacks were occurred against bulk carriers (28.6), Marshall Islands-flagged ships were the most attacked (17.1%). The results of Chi-Square Test show that there is a weak statistical relationship between the piracy attacks by months and regions; there is a weak statistical relationship between the piracy attacks by years and type of attacks. There is no statistical relationship between other variables. In the conclusion part of the study, some suggestions are proposed to combat the maritime piracy.

**Keywords:** *Maritime Security; Maritime Piracy; Maritime Trade; Chi-Square Test.*

## 1. INTRODUCTION

Around 90 percent of global trade by volume carried by sea especially by narrow risky waterway as such as the Strait of Bab el-Mandeb, Suez and Panama Canals, Malacca or Singapore Straits (UNCTAD, 2018). Maritime pirates attack particularly main trade routes especially narrow waterways and straits. The maritime piracy (piracy) is a great threat for the sustainability of seaborne trade. The attacks against ships negatively affect international trade, exporters, importers, crews, ship owners, shippers, container operators, insurance companies, maritime safety and environment (Chew, 2005).

In 2020, 195 pirate attacks were occurred in 2020. The most of the piracy attacks occurred in Nigeria and respectively in Indonesia, Singapore Straits and Benin (IMB, 2020). The highest risky region is Africa with 88 attacks. Other risky regions are South-East Asia, Americas, Indian Sub Continent and East India (IMB, 2020). The Covid-19 pandemic has affected maritime crime. The piracy attacks against ships increased in 2020 during the pandemic period. Violent piracy attacks against ships and their crews have increased especially Nigeria, Indonesia, Singapore Straits and Benin during the Covid-19 period. The Covid-19 pandemic negatively affects the global economy, growth rates, job losses, international trade, poverty (Homeland Security, 2021).

While the reason of most maritime piracy attacks are robs of money, some may be for political or social purposes (Mo, 2002). The main reasons of maritime piracy can be listed as follows: economic crisis in Southeast Asia, low wages, high unemployment rates, poverty and inadequate education, insufficient coastline and port surveillance, regional political and economic instability especially in Somalia, corruption, insufficient judicial structures and loopholes in legal instruments, local law enforcement, demand ransom illegal foreign fishing trawlers, serious damaging of marine ecosystem due to discharging of hazardous wastes such as toxic and chemical along Somalia's coast by foreign ships during the period the civil war in early 1980s in Somalis (Chalk, 2008; Ece, 2012; UNEP, 2005). Piracy attacks increased due to the willingness of shipowners to pay large sums of money for the return of their cargo and ships (Chalk, 2009). The piracy attacks have the potential threat for environment and could cause environmental pollution and damage to maritime life and other offshore resources (Chalk, 1998).

Several studies have been carried out on the maritime piracy until today. Chalk (1998) analyzed maritime piracy in the Southeast Asian region. Some of the suggestions of the study are providing assistance by flag states in the form of maritime funds, training, and equipment, creation of effective multilateral joint patrol areas in the Southeast Asia (Chalk, 1998). Nincic (2009) discussed in maritime piracy in Africa from the point of the humanitarian dimension. As a result of the study, it is emphasized that piracy attacks poses a vital threat for fishing industry, regional trade, economy, living conditions of the poor people who live in this region (Nincic, 2009).

Pristrom *et al.* (2013) analyzed maritime piracy attacks to find the factors that cause piracy. One of the results of the analysis shows that the threat of maritime piracy can be mitigate by a number of shipboard measures. Okoronkwo *et al.* (2014) discussed maritime piracy in Niigeria. Martínez-Zarzoso and Bensassi (2013) investigated impact of piracy on maritime transport costs. The results of the

study show that maritime piracy significantly increases trade costs between Europe and Asia.

Flückiger and Ludwig (2015) analyzed the link between economic shocks in the fisheries sector and the incidence of piracy. The findings of the analysis that plankton abundance is positively concerning fish catches, but negatively associated with the piracy attacks. Some suggestions of the study are sanitization of the countries' political process, strengthening building capacities in security agencies in Nigerian waterways and strengthening security operations and intelligence gathering concerning maritime security. Özdemir and Güneroğlu (2017) analyzed piracy attacks by using applying fuzzy AHP and fuzzy TOPSIS methodologies. One of the results of the study is that economic insufficiency is the most effective cause of the maritime piracy. One of the suggestions of this study is that local and regional authority in risky regions should be supported. The use of private armed guards onboard ships has increased due to the growing maritime piracy (Ahmad, 2020). The International Maritime Organization (IMO) is issuing guidelines on the use of private armed guards to protect ships from piracy (IMO, 2021a). Shepardi and Pratson (2020) has analyzed the effect of maritime piracy through this chokepoint on exports of specific fuels from each Persian Gulf Countries (PGC) by using use a two-stage least squares regression. The result of the analysis indicates that tanker transit declines two years after piracy attacks in PGC region and only refined petroleum exports from Bahrain and Kuwait are significantly impacted. Using data on attacks on ships reported between 1996 and 2005, Majia *et al.* inquired whether the acts of piracy were truly random. The results of the study show that both type of vessel and flag of registry are significant factors maritime piracy and the ship types most subject to attacks are bulk carriers followed by general cargo ships, container ships, tankers, chemical and products carriers (Mejia *et al.*, 2009).

Due to the limited number of studies on the quantitative analysis of maritime piracy in the literature, this study is designed to fill this gap. The aim of the study is to analyze maritime piracy attacks between 2015 to 2020 by using quantitative methods such as frequency distribution, the Chi Square Test ( $\chi^2$ ) and Cramer V's Test. The reason for using the Chi-Square Test is that the variables are categorical and to determine if observed results are in line with expected results.

The paper is organized in five sections. In the introduction part of the study, a literature review on piracy was conducted and the reasons of piracy were examined. In the second part of the study, maritime piracy & armed robbery statistics are given. In the third part of the study, international conventions, regulations and efforts to combat maritime piracy are examined. In the fourth part of the study, the frequency distribution was created and the Chi Square Test and Cramer V's Test were used to test whether a statistically relationship between categorical variables. These variables include the piracy attacks by years, months and hours, types, regions and type of vessels attacked. In the conclusion section includes the results of the analysis of the study and some suggestions are proposed to combat the maritime piracy.

## 2. MARITIME PIRACY & ARMED ROBBERY STATISTICS

In 2020, 195 piracy and armed robbery against ships in the worldwide. Total of 400 attacks occurred in Africa and 466 attacks occurred in South East Asia in 2015-2020. The most attacks occurred in Africa (88) and respectively South East Asia (62), America (30), Indian Subcontinent (10) and

East Asia (4) in 2020. The attacks occurred in Africa, South East Asia, Indian Subcontinent and America increased according to the previous year as given in Table 1 (IMB, 2019; IMB, 2020).

The most attacks occurred in Nigeria (35) and respectively Indonesia (26), Singapore Straits (23), Benin (11), Ghana (9), Peru and Philippines in 2020 as shown in Table 2 (IMB, 2019; IMB, 2020)

Table 1. Actual and attempted piracy attacks by regions

Region	2015	2016	2017	2018	2019	2020
Africa	35	62	57	87	71	88
South East Asia	147	68	76	60	53	62
Indian Subcont	24	17	15	18	4	10
America	8	27	24	29	29	30
East Asia	31	16	4	7	5	4
Rest of World	1	1	4	-	-	1
Total	246	191	180	201	162	195

Source: International Chamber of Commerce (ICC) IMB 2015-2020 Annual Reports

Table 2. Actual and attempted attacks by locations

Location	2015	2016	2017	2018	2019	2020
<b>South East Asia</b>						
Indonesia	108	49	43	36	25	26
Malaysia	13	7	7	11	11	4
Philippines	11	10	22	10	5	8
Singapore Straits	-	2	4	3	12	23
<b>East Asia</b>						
Vietnam	27	9	2	4	2	4
<b>Indian Sub Continent</b>						
Bangladesh	11	3	11	12	-	4
India	13	14	4	6	4	6
<b>South America</b>						
Brazil	-	-	-	4	2	7
Haiti	-	4	1	3	2	5
Mexico	-	1	-	-	1	4
Peru	-	11	2	4	10	8
<b>Africa</b>						
Angola	-	2	1	-	-	6
Benin	-	1	-	5	3	11
Ghana	-	3	1	10	3	9
Guinea	-	3	2	3	2	5
Gulf of Aden	-	1	3	1	-	-
Mozambique	-	1	2	2	3	4
Nigeria	14	36	33	48	35	35
Somalia	-	1	5	2	-	-
Rest of the World	49	44	57	75	68	100
Total	246	191	180	201	162	195

Source: ICC IMB 2015-2020 Annual Reports

The piracy attacks in Bangladesh have decreased significantly in recent years due to the efforts of Bangladesh authorities. Most piracy attacks were occurred Chittagong

anhorages and approaches. The attacks have also fallen in Indonesia due to close collaboration between Indonesian Marine Policy and IMB PRC. The attacks in Malacca

Straits has dropped significantly due to patrols by literal states. Merchant vessels are at risk in Malaysia. Therefore, the ships are advised to take precautionary measures. The piracy attacks have increased in Benin. The pirates/robbers are often well armed, violent in Nigeria. The pirates have attacked and hijacked/robbed ships/kidnapped crews in this location (ICC, 2021).

The piracy statistics by attack type between 2015-2020 are 142 attempted, 923 boarded attacks and 69 fired upon. Attempted and boarded attacks increased and hijack

decreased in 2020 according to the previous year significantly as shown in Table 3 (IMB, 2019; IMB, 2020).

Total of 508 kidnap/ransom and 747 hostage events occurred between 2015-2020 as given in Table 4 (IMB, 2019; IMB, 2020). Kidnap/ransom increased and hostage in decreased in 2020 according to the previous year (IMB, 2019; IMB, 2020).

In 80% of the Gulf of the Guinea attacks, the attacks were armed with guns (IMB, 2020).

Table 3. The type of attacks by years

Type of attacks	2015	2016	2017	2018	2019	2020
Attempted	27	22	22	34	17	20
Boarded	203	150	136	143	130	161
Fired Upon	1	12	16	18	11	11
Hijack	15	7	6	6	4	3
Total	246	191	180	201	162	195

Source: ICC IMB 2015-2020 Annual Reports

Table 4. Types of violence to crew by years

Type of Violence	2015	2016	2017	2018	2019	2020
Assaulted	14	5	6	-	3	5
Hostage	271	151	91	141	59	34
Injured	14	8	6	8	7	9
Kidnap/Ransom	19	62	75	83	134	135
Killed	1	-	3	-	1	-
Threatened	14	10	10	9	6	8
Total	333	236	191	241	210	191

Source: ICC IMB 2015-2020 Annual Reports

Table 5. Types of arms used during attacks January-December 2003-2009

Types of arms	2015	2016	2017	2018	2019	2020
Guns	33	48	52	56	47	69
Knives	97	44	44	36	36	46
Not stated	108	96	80	104	74	76
Other weapons	8	3	4	5	5	4
Total	246	191	180	201	162	195

Source: ICC IMB 2015-2020 Annual Reports

Guns are the most used arms and respectively knives. Total of 69 guns and 46 knives were used in 2020 as shown in Table 5 (IMB, 2019; IMB, 2020).

### 3. INTERNATIONAL CONVENTIONS, REGULATIONS AND EFFORTS TO COMBAT MARITIME PIRACY

International Maritime Organization (IMO), The European Union (EU) and other related organizations adapted legal and other regulations to combat maritime piracy. The major international conventions, regulations and efforts concerning anti-maritime piracy are can be classified as the following;

#### a) Geneva Convention on the High Seas 1958

In 1958, the Geneva Convention on the High Seas came into force on 10 June 1964. The Convention set out the first formal definition of piracy (Art 15).

#### b) The United Nations Convention on the Law of the Sea (UNCLOS) 1982

UNCLOS includes number of provisions related to maritime piracy. The articles 100-107 and 110 set out the principles on anti-piracy. "Article 100 of the UNCLOS provides that all States to cooperate to the fullest possible extent in the repression of piracy on the high seas or in any other place outside the jurisdiction of any State (UNCLOS, 1982)".

According to the article 105 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 (UNCLOS, 1982)". Article 107 of UNCLOS concerns to "Ships and aircraft which are entitled to seize on account of piracy(UNCLOS, 1982)".

The definition of the piracy defines in article 101 of UNCLOS as follows (UNCLOS, 1982):

"Piracy consists of any of the following acts:

(a) 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:

(i) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;

(ii) against a ship, aircraft, persons or property in a place outside the jurisdiction of any State;

(b) 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;

(c) any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b) (UNCLOS, 1982)".

c) The Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation 1988 (SUA).

The purpose of the SUA Convention is to ensure that appropriate action is taken against persons who commit unlawful acts against ships in accordance with international law. (Çaycı, 2009). The amendments were adopted in the form of Protocols to the SUA treaties (the 2005 Protocols) (IMO, 2021b).

d) The United Nations Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances, 1988 (Article 17).

e) The United Nations (UN) Security Council Resolutions 1801 (2008), 1816 (2008), 1838 (2008), 1844 (2008), 1846 (2008), 1851 (2008) and of UN General Assembly Resolution 63/111 which provide recommendations to combat the maritime piracy (Çaycı, 2009).

f) International Maritime Organization (IMO) resolutions and circulars contains recommendations and measures to governments, ship operators, shipowners and crews to cope with the piracy. The International Ship and Port Facility Security (ISPS) Code which came into force on 1 July 2004 was adopted into the International Convention for the Safety of Life at Sea (SOLAS), 1974 to increase maritime security measures for ships and port facilities (IMO, 2021c). The ISPS Code is to ensure that the applicable ocean going of IMO Member States are implementing the highest possible standards of security. The ISPS Code divided into two sections. The Part A is mandatory which a series of guidelines and Part B which is non-mandatory contains how to meet those requirements (IMO, 2015; IMO, 2021d).

g) The Djibouti Code come into force on January 29, 2009 to repress of piracy and armed robbery against ships in the Western Indian Ocean and the Gulf of Aden. The purpose of the Code is to implement and/or reinforce some activities such as establishment of Regional Training Centre and Piracy Information Exchange Centres (IMO, 2013).

h) The European Union (EU) legislation consists in the combination of preventive measures contained in the Regulation on enhancing ship and port facility security.

EU) legislation on maritime security are given as follows (ec.europa.eu, 2015).

i) European legislation concerning maritime security such as Ship and port facility security: Regulation (EC) No 725/2004, Port Security Directive, Commission Regulations to enhance ship and port facilities.

j) The Regional Cooperation Agreement on Combating Piracy and Armed Robbery against ships in Asia (RECAAP) set up the RECAAP Information Sharing Centre (ISC) for facilitating the sharing of piracy-related information to combat the piracy (UNCTAD, 2014).

k) Military and naval antipiracy patrols such as NATO Combined Task Forces, NATO's Standing Naval Force Mediterranean (STANAVFORMED) the EU Operation Atalanta and other States's naval forces take measures to secure the high risky areas by escorting commercial vessels (UNCTAD, 2014). The International Recommended Transit Corridor (IRTC) which is a shipping route with 490 nautical miles long and 20 nautical miles wide. through the Gulf of Aden is patrolled against pirates by international naval forces(IMO, 2009).

l) The coastguards, marine police, customs and other government agencies engaged in Southeast Asia countries have taken measures to combat the maritime piracy. All coastal states such as Malaysia, Indonesia, and Singapore have conducted joint naval patrols (Alessi and Hanson, 2012).

m) Maritime security technologies such as Automatic Identification System (AIS), the Long Range Identification and Tracking (LRIT) System have been introduced to help shipowners, ship masters, and crews to combat maritime piracy (Pristrom *et al*, 2013.).

n) The Montreux Document on Private Military and Security Companies. The Montreux Document covers Pertinent international legal obligations and good practices for states related to operations of private military and security companies during armed conflict. The Montreux Document which was finalized by consensus on 17 September 2008 by 17 States. The Document has aimed to promote respect for International humanitarian law and human rights law whenever private military and security companies are present in armed conflicts (ICRC, 2020).

o) Best Management Practices for Protection against Somalia Based Piracy offered specific and practical advices to help ships to avoid, deter or delay piracy attacks in the High Risk Areasuch as the Gulf of Aden, off the Coast of Somalia and in the Western Indian Ocean.

As mentioned above, the piracy attacks have decreased significantly due to the measures such as implementation of International Recommended Transit Corridor, Best Management Practices, ship protection measures, maritime security technologies, International Maritime Organization (IMO) resolutions and circulars concerning piracy; the Djibouti Code to mitigate piracy in the Western Indian Ocean and the Gulf of Aden; The Regional Cooperation Agreement on Combating Piracy and Armed Robbery against ships Asia and efforts of anti-piracy operations.

#### 4. METHODOLOGY

The piracy and armed robbery attacks data are obtained from the Piracy and Armed Robbery Incidents statistics of the ICC International Maritime Bureau's "Piracy and Armed Robbery Against Ships" Annual Reports for in the period 2015 and 2020. The piracy and armed robbery attacks data base contains total of 7.050 nonparametric data

which includes 1.175 actual and attempted attacks records such as attacks by years; type of attacks; type of vessels attacked; attacks by regions and locations. The frequency distribution was created and Chi Square and Cramer's Value Tests were used to test statistical relationship between categorical variables such as piracy attacks by years, months and hours, types, regions and type of vessels attacked. The variables have divided sub groups by using the classification scale.

#### 4.1. Frequency Distribution of Piracy Attacks

The most piracy attacks occurred in 2015 (20.9%) between 2015 and 2020 as given in Table 6 and Figure 1. Piracy attacks increased by 20% in 2020 compared with the previous year.

Table 6. Frequency distribution of actual and attempted piracy attacks by years

Attacks by years	Frequency	Percent. (%)	Total Cumulative Percent. (%)
2015	246	20.9	20.9
2016	191	16.3	37.2
2017	180	15.3	52.5
2018	201	17.1	69.6
2019	162	13.8	83.4
2020	195	16.6	100.0
Total	1,175	100.0	

Source: ICC IMB 2015-2020 Annual Reports

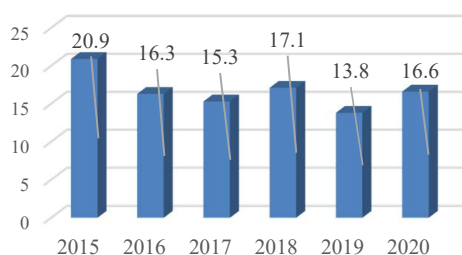


Fig.1. Actual and attempted piracy attacks by years  
Source: ICC IMB 2015-2020 Annual Reports

The most attacks occurred in South East Asia (42.6%) and respectively Africa (33.7%), America (12.5%), Indian Subcontinent (7.7%) and East Asia (2.9%) between 2015 and 2020 as given in Table 7 and Figure 2.

Table 7. Frequency distribution of actual and attempted piracy attacks by regions

Attacks by regions	Freq.	Percent. (%)	Total Cum. Percent. (%)
Africa	396	33.7	33.7
South East Asia	500	42.6	76.3
Indian Subcontinent	91	7.7	84.0
America	147	12.5	96.5
East Asia	34	2.9	99.4
Rest of World	7	0.6	100.0
Total	1,175	100.0	

Source: ICC IMB 2015-2020 Annual Reports

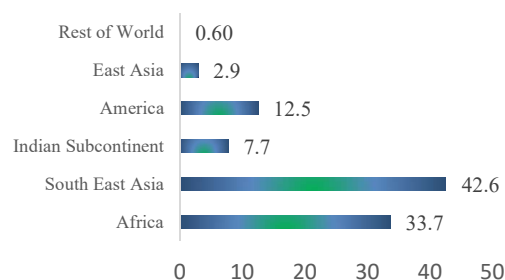


Fig.2. Actual and attempted piracy attacks by regions  
Source: ICC IMB 2015-2020 Annual Reports

The most attacks were occurred in the months in March-April-May (30.2%) and respectively Dec-Jan- Feb (24.9%), Sep-Oct-Nov (24.6%) and June-July-Aug (20.3%) between 2015 and 2020 as given in Table 8.

Table 8. Frequency distribution of actual and attempted piracy attacks by months of attacks

Months of attacks	Freq.	Percent. (%)	Total Cumulative Percent. (%)
Dec-Jan- Feb	293	24.9	24.9
March-April-May	355	30.2	55.1
June-July-Aug	238	20.3	75.4
Sep-Oct-Nov	289	24.6	100.0
Total	1,175	100.0	

Source: ICC IMB 2015-2020 Annual Reports

The most attacks were occurred between the hours 24:00-04:00 (29.2%) and respectively 04:00-08:00 (20.7%), 20:00-24:00 (16.3%), 16:00-20:00 (15.3%), 12:00-16:00 (8.7%) and 08:00-12:00 (8%) between 2015 and 2020 as given in Table 9.

Table 9. Frequency distribution of actual and attempted piracy attacks by hours of attacks

Hours of attacks	Freq.	Percent (%)	Total Cum. Per. (%)
NA	22	1.9	1.9
24:00 - 04:00	343	29.2	31.1
04:01 - 08:00	243	20.7	51.7
08:01 - 12:00	94	8.0	59.7
12:01 - 16:00	102	8.7	68.4
16:01 - 20:00	180	15.3	83.7
20:01 - 24:00	191	16.3	100.0
<b>Total</b>	<b>1,175</b>	<b>100.0</b>	

Source: ICC IMB 2015-2020 Annual Reports

929 ships were boarded (79.1%) and respectively attempted (12%), fired upon (5.8%) and hijack (3.1%) in the period of 2015-2020 as given in Table 10.

Table 10. Frequency distribution of type of piracy attacks

Type of attacks	Freq.	Percent (%)	Total Cumulative Percent. (%)
Attempted	141	12.0	12.0
Fired upon	68	5.8	17.8
Hijack	37	3.1	20.9
Boarded	929	79.1	100.0
<b>Total</b>	<b>1,175</b>	<b>100.0</b>	

Source: ICC IMB 2015-2020 Annual Reports

Bulk carrier ships were the most attacked (28.6%) and respectively product tankers (21.0%), container ships (10.2%) in the period of 2015-2020 as given in Table 11. The results of the descriptive statistics of the study conducted by Mejia *et al* (2009) also show that the ship types most subject to attacks are bulk carriers (Mejia et al, 2009).

Table 11. Actual and attempted piracy attacks by type of ships attacked

Type of ships attacked	Freq.	Percent (%)	Cumulative Percent (%)
Fishing ship	18	1.5	1.5
General cargo	65	5.5	7.1
Bulk carrier	336	28.6	35.7
Container	120	10.2	45.9
Tanker	99	8.4	54.3
Chemical tanker	54	4.6	58.9
Product tanker	247	21.0	79.9
LPG tanker	50	4.3	84.2
Refrigerated vessel	17	1.4	85.6
Vehicle carrier	7	0.6	86.2
Yacht	1	.1	86.3
Tug	42	3.6	89.9
Others	119	10.1	100.0
<b>Total</b>	<b>1,175</b>	<b>100.0</b>	

Source: ICC IMB 2015-2020 Annual Reports

Marshall Islands -flagged ships were the most attacked (17.1%) and respectively Panama-flagged ships(15.1%), Singapore-flagged ships ((14.2%) and Liberia-flagged ships (11.5%), Singapore-flagged ships ((14.2%) and Liberia-flagged ships (11.5%) as given in Table 12.

Table 12. Actual and attempted piracy attacks by ship's flag attacked

Ship's flag attacked	Freq.	Percent (%)	Cumul Perc..(%)
NA	8	0.7	0.7
Europe (Exc.Malta)	7	0.6	1.3
Malta	42	3.6	4.9
USA/Cont America	3	0.3	5.1
Hong Kong	68	5.8	10.9
Marshall Islands	201	17.1	28.0
Antigua&Barbuda	14	1.2	29.2
Singapore	167	14.2	43.4
Panama	178	15.1	58.6
Liberia	135	11.5	70.0
Malaysia	35	3.0	73.0
Indonesia	21	1.8	74.8
Others	296	25.2	100.0
<b>Total</b>	<b>1,175</b>	<b>100.0</b>	

Source: ICC IMB 2015-2020 Annual Reports

## 4.2. Chi-Square Test

In the study, Chi-Square Test ( $\chi^2$ ) which is a quantitative measure was used to analyze whether a relationship exists between the non parametric variables for the period in 2015-2020. The reason for using the Chi-Square Test is that the variables are categorical and to determine if observed results are in line with expected results. The significance level ( $\alpha$ ) was set at 5%.

It was tested a hypothesis  $H_0$  that fully specifies  $p^1, \dots, p_k$ ,

$$H_0: p_1 = p_1^{(0)}, ; p_2 = p_2^{(0)}, \dots, p_k = p_k^{(0)},$$

The formula for the  $\chi^2$  test statistic is:

$$\chi^2 = \sum_{i=1}^k \frac{(\text{Observedvalue} - \text{Expectedvalue})^2}{\text{Expectedvalue}} \quad (1)$$

We can safely use the Chi-Square Test when the samples are simple random samples; all individual expected counts should be 1; no more than 20% of expected counts are less than 5; the minimum expected count is at least equal to 1. The P-value which is the probability of observing a sample statistic should also less than the significance level at 0.05 (Cochran, 1954: 417-451; Sheskin, D.J, 2004). Cramer's V Test was used to determine the strength of the relationship between two variables.

### 4.2.1. The Chi-Square Test between year of attack and region of attack

Total of 1,175 piracy attacks occurred during the period 2015 to 2020. Most of the attacks occurred in 2015 (246

attacks). The least number of attacks occurred in 2019 (162 attacks) as given in Table 13. The most of the attacks in Africa were occurred in 2020 (85) and respectively in South East Asia (177) in 2015, Indian Sub Continent in 2015 and 2017 (20) and Far East in 2016 (15) as shown in Table 13 (IMB ICC, 2015-2020).

The piracy attacks in all regions increased in 2020 except Far East. The piracy attacks increased by 24% as of May 15 in 2020 compared with the same period in 2019 (Oyenug, 2021).

The null hypotheses (H<sub>0</sub>): There is no statistical relationship between year of attack and region of attack and the alternative hypotheses (H<sub>1</sub>): There is statistical relationship between year of attack and region of attack

The value of  $\chi^2$  Test is 174.803, 19.4% of expected counts < 5, P-value (0.00) < the significance level ( $\alpha=0.05$ ),

but minimum expected count < 1 (0.97) as shown in Table 14. Therefore, the  $\chi^2$  Test can not be used safely.

#### 4.2.2. The Chi-Square Test between month of attack and region of attack

The most of the attacks occurred in Africa (111), South Asia (158) and Americas (47) were occurred in March-May and respectively Indian Sub-Continent (44) and Far East (15) in December-February in the period 2015 to 2020 as shown in Table 15 (IMB ICC, 2015-2020).

H<sub>0</sub>: There is no statistical relationship between month of attack and region of attack and H<sub>1</sub>: There is statistical relationship between month of attack and region of attack.

Table 13. Crosstabulation between year of attack and region of attack (2015-2020)

Years	Count % within attacks by years	Africa	South East Asia	Indian Sub Cont.	Americas	Far East	Others	Total
2015	Count	35	177	20	8	5	1	246
	Expected Count	82.9	104.7	19.1	30.8	7.1	1.5	246.0
	%wit.attack year	14.2%	72.0%	8.1%	3.3%	2.0%	.4%	100.0%
2016	Count	62	69	17	27	15	1	191
	Expec. Count	64.4	81.3	14.8	23.9	5.5	1.1	191.0
	%wit.attack year	32.5%	36.1%	8.9%	14.1%	7.9%	0.5%	100.0%
2017	Count	56	74	20	24	2	4	180
	Expec. Count	60.7	76.6	13.9	22.5	5.2	1.1	180.0
	%wit.attack year	31.1%	41.1%	11.1%	13.3%	1.1%	2.2%	100.0%
2018	Count	87	63	19	29	3	0	201
	Expec. Count	67.7	85.5	15.6	25.1	5.8	1.2	201.0
	%wit.attack year	43.3%	31.3%	9.5%	14.4%	1.5%	0.0%	100.0%
2019	Count	71	53	4	29	5	0	162
	Expec. Count	54.6	68.9	12.5	20.3	4.7	1.0	162.0
	%wit.attack year	43.8%	32.7%	2.5%	17.9%	3.1%	0.0%	100.0%
2020	Count	85	64	11	30	4	1	195
	Expec. Count	65.7	83.0	15.1	24.4	5.6	1.2	195.0
	%wit.attack year	43.6%	32.8%	5.6%	15.4%	2.1%	.5%	100.0%
Total	Count	396	500	91	147	34	7	1175
	Expec. Count	396.0	500.0	91.0	147.0	34.0	7.0	1,175.0
	%wit.attack year	33.7%	42.6%	7.7%	12.5%	2.9%	.6%	100.0%

Table 14. The Chi-Square Test between year of attack and region of attack (2015-2020)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	174.803 <sup>a</sup>	25	0.000
Likelihood Ratio	177.035	25	0.000
Linear-by-Linear Relationship	3.377	1	0.066
Cramer's V (Approx. Sig.)	0.172		0.000
Number of Valid Cases	1,175		

a. 7 cells (19.4%) have expected count less than 5.

The minimum expected count is 0.97.



Table 15. Crosstabulation between month of attack and region of attack (2015-2020)

Months	Count/ Count %within months	Expected attack	Africa	South East Asia	Indian Sub Cont.	Americas	Far East	Others	Total
December- February	Count		111	90	44	32	15	1	293
	Expect. Count		98.7	124.7	22.7	36.7	8.5	1.7	293.0
	%wit. attac. months		37.9%	30.7%	15.0%	10.9%	5.1%	.3%	100.0%
March - May	Count		121	158	17	47	9	3	355
	Expect. Count		119.6	151.1	27.5	44.4	10.3	2.1	355.0
	%wit. attac. months		34.1%	44.5%	4.8%	13.2%	2.5%	.8%	100.0%
June - August	Count		66	119	15	33	4	1	238
	Expect. Count		80.2	101.3	18.4	29.8	6.9	1.4	238.0
	%wit. attac. months		27.7%	50.0%	6.3%	13.9%	1.7%	.4%	100.0%
September- November	Count		98	133	15	35	6	2	289
	Expect. Count		97.4	123.0	22.4	36.2	8.4	1.7	289.0
	%wit. attac. months		33.9%	46.0%	5.2%	12.1%	2.1%	0.7%	100.0%
Total	Count		396	500	91	147	34	7	1,175
	Expect. Count		396.0	500.0	91.0	147.0	34.0	7.0	1,175.0
	%wit. attac. months		33.7%	42.6%	7.7%	12.5%	2.9%	0.6%	100.0%

Table 16. The Chi-Square Test between month of attack and region of attack (2015-2020)

	Value	df	Asymp. Sig. (2- sided)
Pearson Chi-Square	54.065 <sup>a</sup>	15	0.000
Likelihood Ratio	51.066	15	0.000
Linear-by-Linear Relationship	0.960	1	0.327
Cramer's V (Approx. Sig.)	0.124		0.000
Number of Valid Cases	1,175		

a. 4 cells (16.7%) have expected count less than 5.  
The minimum expected count is 1.42.

The value of  $\chi^2=54.065$ ,  $P=0.000$ , Likelihood Ratio =51.066, 4 cells (16.7%) have expected count < 5. The minimum expected count is 1.42, 16.7% of expected counts are less than 5 as given in Table 16. The minimum expected count is more than 1 (1.42). P value (0.00) <  $\alpha = 0.05$ . Therefore,  $H_0$  is rejected,  $H_1$  is accepted. There is statistical relationship between month of attack and region of attack. Cramer's V value (12.4%) confirms that there is a weak statistical relationship between month of attack and region of attack.

#### 4.2.3. The Chi-Square Test between hour of attack and region of attack

The piracy attacks in Africa, Indian Sub Continent, Americas and Far East were occurred between the hours 24:00-04:00. The most attacks in South Asia were occurred between the hours 16:00-20:00 in the period 2015 to 2020 as given in Table 17 (IMB ICC, 2015-2020).

$H_0$ : There is no statistical relationship between hour of attack and region of attack and  $H_1$ : There is statistical relationship between hour of attack and region of attack.

Table 18. Chi-Square Test between hour of attack and region of attack (2015-2020)

	Value	df	Asymp. (2-sided)
Pearson Chi-Square	175.992 <sup>a</sup>	30	0.000
Likelihood Ratio	182.454	30	0.000
Linear-by-Linear Relationship	0.370	1	0.543
Cramer's V (Approx. Sig.)	0.173		0.000
Number of Valid Cases	1,175		

a. 12 cells (28.6%) have expected count less than 5.  
The minimum expected count is 0.13.

The value of  $\chi^2 = 175.992$ , Likelihood Ratio = 182.454, 28.6% of expected counts < 5, P-value (0.00) <  $\alpha = 0.05$ , but minimum expected count < 1 (0.13) as shown in Table 18. Therefore, the  $\chi^2$  Test can not be used safely.

#### 4.2.4. The Chi-Square Test between year of attack and types of attack

The most attempted and fired upon occurred in 2018. The most ships hijacked and boarded occurred in 2015 as shown in Table 19. The attacks decreased significantly due to anti-piracy measures and anti- operations (IMB ICC, 2015-2020).

$H_0$ : There is no statistical relationship between year of attack and types of attack,  $H_1$ : There is statistical relationship between year of attack and types of attack.

Table 17. Crosstabulation between hour of attack and region of attack (2015-2020)

Hours	Count/ Expected Count/% within attack hour	Africa	South East Asia	Indian Sub Cont.	Americas	Far East	Others	Total
NA	Count	8	10	2	1	1	0	22
	Expect. Count	7.4	9.4	1.7	2.8	.6	0.1	22.0
	%wit.attac. hour	36.4%	45.5%	9.1%	4.5%	4.5%	0.0%	100.0%
2400 - 0400	Count	153	106	26	46	12	0	343
	Expect. Count	115.6	146.0	26.6	42.9	9.9	2.0	343.0
	%wit.attac. hour	44.6%	30.9%	7.6%	13.4%	3.5%	0.0%	100.0%
0400 - 0800	Count	76	81	13	67	3	3	243
	Expect. Count	81.9	103.4	18.8	30.4	7.0	1.4	243.0
	%wit.attac. hour	31.3%	33.3%	5.3%	27.6%	1.2%	1.2%	100.0%
08:01 - 12:00	Count	42	32	3	16	1	0	94
	Expect. Count	31.7	40.0	7.3	11.8	2.7	0.6	94.0
	%wit.attac. hour	44.7%	34.0%	3.2%	17.0%	1.1%	0.0%	100.0%
1200 - 1600	Count	25	56	12	4	5	0	102
	Expect. Count	34.4	43.4	7.9	12.8	3.0	0.6	102.0
	%wit.attac. hour	24.5%	54.9%	11.8%	3.9%	4.9%	.0%	100.0%
1600 - 2000	Count	35	114	17	3	9	2	180
	Expect. Count	60.7	76.6	13.9	22.5	5.2	1.1	180.0
	%wit.attac. hour	19.4%	63.3%	9.4%	1.7%	5.0%	1.1%	100.0%
2000 - 2400	Count	57	101	18	10	3	2	191
	Expect. Count	64.4	81.3	14.8	23.9	5.5	1.1	191.0
	%wit.attac. hour	29.8%	52.9%	9.4%	5.2%	1.6%	1.0%	100.0%
Total	Count	396	500	91	147	34	7	1,175
	Expect. Count	396.0	500.0	91.0	147.0	34.0	7.0	1,175.0
	%wit.attac. hour	33.7%	42.6%	7.7%	12.5%	2.9%	0.6%	100.0%

Table 19. Crosstabulation between year of attack and types of attack (2015-2020)

Years	Count % within attack year	Attempted	Fired upon	Hijack	Boarded	Total
2015	Count	28	1	14	203	246
	Expec.Count	29.5	14.2	7.7	194.5	246.0
	%wit. attack year	11.4%	.4%	5.7%	82.5%	100.0%
2016	Count	23	11	7	150	191
	Expec.Count	22.9	11.1	6.0	151.0	191.0
	%wit. attack year	12.0%	5.8%	3.7%	78.5%	100.0%
2017	Count	22	16	4	138	180
	Expec.Count	21.6	10.4	5.7	142.3	180.0
	%wit. attack year	12.2%	8.9%	2.2%	76.7%	100.0%
2018	Count	33	18	5	145	201
	Expec.Count	24.1	11.6	6.3	158.9	201.0
	%wit. attack year	16.4%	9.0%	2.5%	72.1%	100.0%
2019	Count	17	11	4	130	162
	Expec.Count	19.4	9.4	5.1	128.1	162.0
	%wit. attack year	10.5%	6.8%	2.5%	80.2%	100.0%
2020	Count	18	11	3	163	195
	Expec.Count	23.4	11.3	6.1	154.2	195.0
	%wit. attack year	9.2%	5.6%	1.5%	83.6%	100.0%
Total	Count	141	68	37	929	1,175
	Expec.Count	141.0	68.0	37.0	929.0	1,175.0
	%wit. attack year	1.,0%	5.8%	3.1%	79.1%	100.0%

Table 20. Chi-Square Test between year of attack and types of attack (2015-2020)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	34.068 <sup>a</sup>	15	0.003
Likelihood Ratio	41.267	15	0.000
Linear-by-Linear Relationship	0.068	1	0.794
Cramer's V (Approx. Sig.)	0.098		0.003
Number of Valid Cases	1,175		

a. 0 cells (0.0%) have expected count less than 5.  
The minimum expected count is 5.10.

The value of  $\chi^2=34.068$ ,  $P=0.003$ , Likelihood Ratio=41.267, 0 cells (0.0%) have expected count < 5. The

minimum expected count is 5.10.  $P=0.00 < \alpha = 0.05$  as given in Table 20. Therefore,  $H_0$  is rejected,  $H_1$  is accepted. There is statistical relationship between year of attack and types of attack. Cramer's V value (9.8%) confirms that there is a weak statistical relationship between year of attack and types of attack (IMB ICC, 2015-2020).

#### 4.2.5. The Chi-Square Test between type of ships attacked and types of attack

The most attempted attacks occurred against tankers (59) and respectively general cargo ships (47). The most fired upon attacks occurred against tankers (41) and respectively general cargo (14). The most hijacked against tankers (20), and respectively general cargo ships (7). The most boarded against general cargo ships (350), and respectively tankers 329) as given in Table 21 (IMB ICC, 2015-2020).

Table 21. Crosstabulation between type of ships attacked and types of attack (2015-2020)

Type of ships	Count % within type of ships attacked	Attempted	Fired upon	Hijack	Boarded	Total
General Cargo	Count	47	14	7	350	418
	Expec.Count	50.2	24.2	13.2	330.3	418.0
	%wit.type of ships attac.	11.2%	3.3%	1.7%	83.7%	100.0%
Container	Count	16	8	0	95	119
	Expec.Count	14.3	6.9	3.8	94.0	119.0
	%wit.type of ships attac.	13.4%	6.7%	.0%	79.8%	100.0%
Tanker	Count	59	41	20	329	449
	Expec.Count	54.0	26.0	14.2	354.8	449.0
	%wit.type of ships attac.	13.1%	9.1%	4.5%	73.3%	100.0%
Vehicle	Count	1	1	0	5	7
	Expec.Count	0.8	0.4	0.2	5.5	7.0
	%wit.type of ships attac.	14.3%	14.3%	0.0%	71.4%	100.0%
Others	Count	18	4	10	148	180
	Expec.Count	21.6	10.4	5.7	142.3	180.0
	%wit.type of ships attac.	10.0%	2.2%	5.6%	82.2%	100.0%
Total	Count	141	68	37	927	1,173
	Expec.Count	141.0	68.0	37.0	927.0	1,173.0
	%wit. attack year	12.0%	5.8%	3.2%	79.0%	100.0%

Table 22. Chi-Square Test between type of ships attacked and types of attack (2015-2020)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	35.382 <sup>a</sup>	12	0.000
Likelihood Ratio	39.568	12	0.000
Linear-by-Linear Relationship	0.417	1	0.518
Cramer's V (Approx. Sig.)	0.100		0.000
Number of Valid Cases	1,175		

a. 4 cells (20.0%) have expected count less than 5.  
The minimum expected count is 0.22.

The  $\chi^2$  value=35,382, Likelihood Ratio = 39.568, 20% of expected counts < 5, P-value (0.00) <  $\alpha = 0.05$ ,. but minimum expected count (0.22) < 1 . as shown in Table 22 Therefore, the Chi Square Test can not be used safely.

#### 4.2.6. The Chi-Square Test between types of attack and region of attack

The most attacks in Africa, South East Asia, Indian Sub Continent, Americas and Far East were occurred boarded in the period between 2015 to 2020 as shown in Table 23.

Table 23. Crosstabulation between types of attack and region of attack (2015 - 2020)

Type of attacks	Count % within type of attacks	Africa	South East Asia	Indian Sub Cont.	Americas	Far East	Others	Total
Attempted	Count	58	53	8	18	4	0	141
	Expec.Count	47.5	60.0	10.9	17.6	4.1	.8	141.0
	%wit. attack types	41.1%	37.6%	5.7%	12.8%	2.8%	.0%	100.0%
Fired Upon	Count	56	4	0	3	0	5	68
	Expec.Count	22.9	28.9	5.3	8.5	2.0	.4	68.0
	%wit. attack types	82.4%	5.9%	0.0%	4.4%	0.0%	7.4%	100.0%
Hijack	Count	19	18	0	0	0	0	37
	Expec.Count	12.5	15.7	2.9	4.6	1.1	.2	37.0
	%wit. attack types	51.4%	48.6%	0.0%	0.0%	0.0%	0.0%	100.0%
Boarded	Count	263	425	83	126	30	2	929
	Expec.Count	313.1	395.3	71.9	116.2	26.9	5.5	929.0
	%wit. attack types	28.3%	45.7%	8.9%	13.6%	3.2%	0.2%	100.0%
Total	Count	396	500	91	147	34	7	1175
	Expec.Count	396.0	500.0	91.0	147.0	34.0	7.0	1175.0
	%wit. attack types	33.7%	42.6%	7.7%	12.5%	2.9%	.6%	100.0%

Table 24. Chi-Square Test between types of attack and region of attack (2015-2020)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	164.830 <sup>a</sup>	15	0.000
Likelihood Ratio	145.912	15	0.000
Linear-by-Linear Relationship	13.130	1	0.000
Cramer's V (Approx. Sig.)	0.216		0.000
Number of Valid Cases	1,175		

a. 8 cells (33.3%) have expected count less than 5. The minimum expected count is 0.22.

The value of  $\chi^2$  is 164.830, Likelihood Ratio= 145.912, 33.3% of expected counts < 5, P-value (0.00) <  $\alpha = 0.05$ , but minimum expected count < 1 (0.22 as shown in Table 24 Therefore, the Chi Square Test can not be used safely.

## 5. CONCLUSION

Maritime piracy is an international crime which is subject to universal jurisdiction. Piracy attacks increased in all regions especially in Africa and South East Asia except Far East. Piracy attacks negatively affect ship owners, exporters, carriers and insurance firms. The piracy attacks may also pose a risk for environment and marine life. This study which used quantitative approaches aims to shed light on the studies concerning the maritime piracy attacks over all the world.

The results of the frequency distributions can be summarized as the following; The most piracy attacks occurred in 2015 (20.9%), the most attacks occurred in South East Asia (42.6%), the most type of attacks against to ships were boarded (79.1%), the most attacks were occurred in the months in March-April-May (30.2%), the most attacks were occurred between the hours 24:00-04:00 (29.2%), the most attacks were occurred against bulk carriers (28.6%). Marshall Islands -flagged ships were the most attacked (17.1%). The most of the attacks in Africa were occurred in 2020. The most of the attacks in Africa,

South Asia and Americas were occurred in March-May. The piracy attacks in Africa, Indian Sub Continent, Americas and Far East were occurred between the hours 24:00-04:00. The most attempted and fired upon were occurred in 2018. The most hijacked and boarded were occurred in 2015. The results of Chi-Square Test show that there is a weak statistical relationship between the piracy attacks by months and the piracy attacks by regions; there is a weak statistical relationship between the piracy attacks by years and type of attacks. There is no statistical relationship between other variables.

Some suggestions are proposed to combat the maritime piracy as the following; Effective coast and port surveillance; creation of crisis management; ship protection measures including physical barriers, enhanced bridge protection and vigilance; ship security plans; close collaboration, joint surveillance and patrol between states in risky regions; training of port and coastline personnel; technical collaboration for the implementation of IMO conventions; effective information gathering and sharing regarding piracy attacks; tracking of financial flows related to pirates; sustainable international efforts to depress piracy attacks; strengthen legal instruments for instituting legal proceedings against pirates.

It is believed that the results of the study can be beneficial academic studies on this field, maritime sector and the decision making on piracy measures taken by the related organizations.

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