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# A Game Theoretic Approach to Maritime Security in the Gulf Of Guinea

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***Abstract:*** **It is often problematic for many West and Central African countries to effectively police their territorial waters and Exclusive Economic Zones (EEZ's). This trickles down to creating significant problems for indigenous communities, tourism, the economy and global security. The Gulf of Guinea (GoG) has been in the spotlight primarily for the ascendency in piratical activities, yet GoG states are beset with "seablindness" partly due to policies which are land-centric and with little or no interest in what goes on in the maritime domain. For them it is difficult to enforce sovereignty due to the area size and their navies inability to exhibit the required deterrent or muscle against forms of maritime insecurity that beset them. While there is an international presence such as EUNAVFOR in the Gulf of Aden, nothing of that nature exist in the Gulf of Guinea, instead in October 2011, Operation Prosperity was jointly formed by the navies of Nigeria and Benin to patrol their territorial waters. This paper analyzes the new wave of pirate attacks and its current and potential impact on maritime security. The three pronged players, namely the shipping vessels (targets), pirates (attackers) and Coast Guard or Navy (defenders) sets the stage to form and develop a game theory approach in making decisions as to utilize the scarce law enforcement resources that are available to Gulf of Guinea states in combating their Maritime Security challenges.**

***Keywords:*** **Decision Making, Game Theory, Gulf Of Guinea, Maritime Domain, Maritime Security, Pirates.**

## 1. INTRODUCTION

### 1.1 PIRACY AND ITS SOCIAL COST:

There are varied interpretations as to the extent of the Gulf of Guinea (GoG) but Anene (2006) puts it at the intersection of the equator (Latitude 0º) and Greenwich Meridian (Longitude 0º) as its location. The GoG stretches over 6000km coastline from Senegal in the West of Africa to Angola in South Africa This is an area which has huge mineral reserves and large oil deposits. A great chunk of Africa's oil production close to about 70% is located in this region (Onuaha, 2010). Spear heading the oil producers are Nigeria and Angola with the capacity to produce about 2 million barrels per day. Other GoG central African countries like Congo-Brazzaville, Gabon and Equatorial Guinea extract about 350,000 barrels per day. There have been recent players in the oil production namely Ghana, Sierra Leone and Sao Tome and Principe (Onuaha, 2010). A significant find was made in September 2009 along the coast Sierra Leone producing around 200 million barrels. Ghana's oil production came on stream on December 15, 2010.

The Jubilee Oil field yielded approximately 120,000 barrels oil per day placing her as the seventh in sub-Saharan Africa. In 2012, West African piracy attacks for the first time over took those off the Horn of Africa, 966 sailors attacked in West Africa against 851 off the coast of Somalia (Benkenstein, 2013). International institutions such as the United Nations (UN) made a clarion call on the regional players to take firm action against all culprits. This culminated in the passage of two UN Resolutions (UNSC Resolution 2018) in 2011 and (UNSC Resolution 2039) in 2012.

Piracy in the GoG has been more violent and systematic. The perpetrators have resorted to using sophisticated modes of operations and utilizing heavy weapons (Nonor, 2012). According to Blombaum (2014) there is recent statistics to back the claim of maritime insecurity in the GoG. In 2014 the tag of "The New Danger Zone" was assigned to the GoG by the International Crisis Group (ICG) for heightened piracy activities in that region (ICG, 2014).

All kinds of interesting definitions are ascribed to the word piracy. It is relevant according to Rubin (1998), to give clarity to the terminology and what the sovereignty of the state ends and its jurisdiction over criminal acts. Modern maritime zones regimes according to Halberstam (1988), gives a clear indication of the lack of update for the definition as per the United Nations Convention on the Laws of the Sea (UNCLOS), when initially the high seas was a mere three nautical miles from the coastline and was likened by Mejia (2003) as gerrymandering of the seas.

## 2. THE DEFINITION

According to the IMO (2014) article 101 of the 1982 United Nations Convention on the Law of the Sea (UNCLOS) is defined as follows:

Piracy consists of the following acts:

(a) *any illegal acts of violence or detention, or any act of depredation, committed for private ends by crew or passengers of a private ship or 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 private ship or aircraft;*

(c) *any act indicating or of intentionally facilitating an act described in sub-paragraph (a) or (b)*

## 3. PETRO – PIRACY

This type of piracy is very characteristic of the GoG where the main focus of the pirates is the valuable cargo the ship is laden with, usually oil (Hart, 2014:2). Oil tankers have been an attractive bait for pirates to fall on (IMB, 2011). As the main interest is the oil cargo, the United Nations Office on Drugs and Crime (UNODC) referred to the act as "petro-piracy" (UNODC 2013:47). In this scenario, the captured crew are treated less violently (Bridger, 2014). Oil cargoes often carried by tankers have a complicated piping system on board for the loading and discharging of the cargo. Skilled and knowledgeable crew are needed to attend to the complex piping work and machinery. Stealing of the oil and seeking the assistance of well coordinated networks allows the oil to be sold ( UNODC 2013:50).

Furthermore, it is worthy to note, that most pirate attacks on small boats go on reported and thus falls outside the International Maritime Bureau (IMB) statistical data. The surge in pirate activities in the GoG is most likely due to the increased discovery and exploration of oil on the coastal states in the Gulf. This sea corridor serves as a primary access route to and from oil producing countries such as Nigeria and Angola.

From figure 1 it is seen that the actions of the pirates is very well thought out. The target selection stage affords the pirates the decision to acquire information on the selected target. The strategizing stage involves gathering of information vital to the attack that will be carried out. It entails knowing the cargo the vessel is carrying, the route the vessel is following and the approximate time the interception can be made. A full scale attack is launched and for vessels that sail many nautical miles from the cost the pirates use a mother ship as a launch pad from which to attack. When the mission is a success the attacked vessel and its cargo mostly oil is sent to an isolated part of the sea and the oil cargo off loaded onto a waiting vessel. The siphoned oil is then sent ashore and landed ashore in stored in tank farms where they are later sold off. However, if an attack was unsuccessful, the pirate returns to her base on the mother ship and waits again for the next prey.

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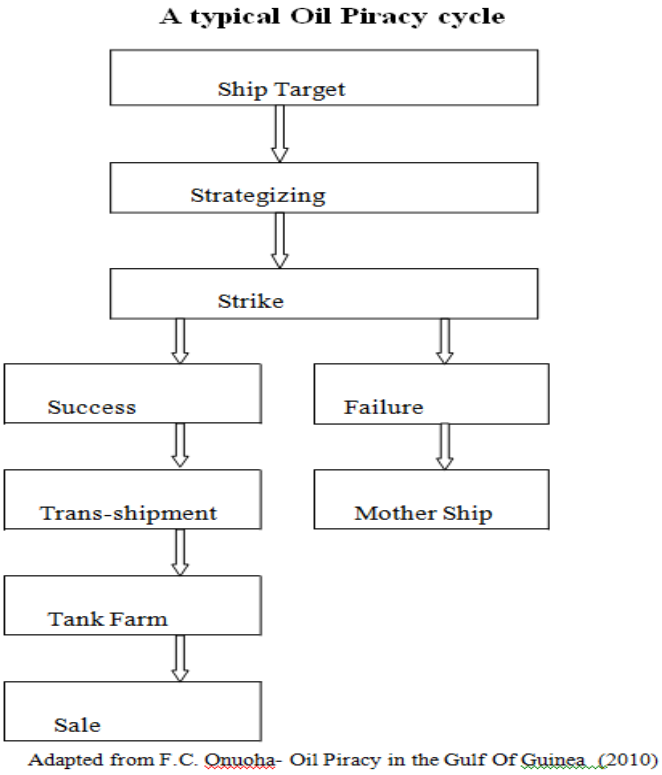


**Fig. 1**

**Table: I Private Attacks in the Gulf of Guinea from 2006 - 2013**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Nigeria | 12 | 42 | 40 | 29 | 19 | 10 | 27 | 31 | 210 |
| Benin | | | | 1 | | 20 | 2 | | 23 |
| Togo | 1 | | 1 | 2 | | 6 | 15 | 7 | 32 |
| Cameroon | 1 | | 2 | 3 | 5 | | 1 | | 12 |
| Ivory Coast | 1 | | 3 | 2 | 4 | 1 | 5 | 4 | 20 |
| Ghana | 3 | 1 | 7 | 3 | | 2 | 2 | 1 | 20 |
| Equatorial Guinea | | | 1 | | | | | | |
| Sao Tome and Principe | | | | | | | | | |
| Gabon | | | | | | | | 2 | 2 |
| Angola | 4 | 1 | 2 | | | 1 | | | 8 |
| **TOTAL** | **22** | **44** | **56** | **40** | **28** | **40** | **52** | **45** | **325** |

*Source: From the ICC, IMB, Piracy and Armed Robbery against ships Annual Report, 2006-2013*

Piracy in the Gulf of Guinea is an old phenomenon. As depicted in Table I, the incidence of piracy does not show an even distribution. The private attacks increased from 22 in 2006 to 44 in 2007 and peaked at 56 in 2008. It declined to 40 in 2009, and further to 28 in 2010. The attacks started to escalate to 40 in 2011 increasing further to 52 in 2012 and decreasing to 45 in 2013. Nigeria's oil rich Niger Delta has been the operational ground for local disgruntled militia groups who dwell on a perceived deprivation of benefits from the oil income by successive governments. Their modus operandi has been attacking of oil tankers and sabotage to oil installations among others.

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**TABLE : II PIRACY IN THE GULF OF GUINEA OVERVIEW ECONOMIC COST FINDINGS**

| | | |
|---|---|---|
| **$983** million TOTAL COST | **$314** million SPENT ON VESSEL PROTECTION MEASURES | **47%** COST BORNE BY INDUSTRY |

Adapted from: The State of Maritime Piracy 2014 Ocean Beyond Piracy

**TABLE:III HUMAN COST FINDINGS**

| | | |
|---|---|---|
| **1035** SEAFARERS SUBJECT TO ATTACKS | **170** SEAFARERS DETAINED OR HELD HOSTAGE | **55%** OF ATTACK INVOLVED WEAPONS |

Adapted from: The State of Maritime Piracy 2014 Ocean Beyond Piracy

**TABLE IV: ECONOMIC COST BEAKDOWN:**

| **Government & Civil Society Costs** | **Industry Employed Vessel Protection Measures** |
|---|---|
| **$380 – 530** million **53%** | **$231- 314** million **31%** |
| Navel Operations | Armed Guards |
| Prosecution & Imprisonment | Delta Port Escort Vessel |
| Counter Piracy Organizations | Security Liaisons |
| | Lagos Escort Vessels |
| | Secure Zones |
| | Security Equipment |

| **Other Industry Cost** |
|---|
| **$136- 139** million |
| Cargo Theft |
| Stolen Goods |
| Insurance |
| Ransom & Associated Payments |
| Labour |

Adapted from: The State of Maritime Piracy 2014 Ocean Beyond Piracy (OBP)

## 4. LITERATURE REVIEW

### 4.1 APPROACHES TO MARITIME SECURITY:

Security must be clearly distinguished from safety. In safety decision making rests with a sole decision maker who accounts for measures to strengthen safety, while in security dual decision makers are involved, one part countering to cause grave damage and the other seeking to salvage the situation. In this instance the attacker (foe) and defender (friend) must each strategize depending on how they envisage their opponent will respond to any choices they decide to make (Lapan and Sandler,1993).

Security is of vital importance so far as there is an adversary out there. In the maritime domain huge security challenges exist in the form of piracy, armed robbery, smuggling of arms, illegal, unreported and unregulated fishing and drug smuggling which must be addressed. It is essential that with the little resources at hand each security threat is dealt with on its own merit taking into account the responses that would be encountered from the adversary if faced head on. Game theory is an appendage of applied mathematics (Sokolowski and Banks, 2009). It has stood as an effective mathematical model when it comes to human behavior pertaining to the making of decisions of strategic value and where choices have to be made which will depend on the choices of the other party (Sokolowski and Banks, 2009).

John von Newmann and Oskar Morgenstern in their 1944 publication , *The Theory of Games and Economic Behavior*, first gave us a glimpse that game theory is applicable in economic instances. Diverse mathematical representations and simulations have been utilized afterwards in various fields to create scenarios typically involving two players or more who make use of strategies to optimize their respective payoffs.

The US Coast Guard (USCG) is responsible for protecting their coastline, port, and inland waterways. This is a daunting task as they are faced with threats from drug trafficking, terrorist acts and illegal, unreported and unregulated fishing (UUF).

Traditional methods of combating these situations did not yield the desire results. To meet their security goals, the USCG devised an approach using an analytical means to achieve or arrive at strategic decisions in the encounter with rational actors. Game theory served this purpose as it aided in the decision-making process. It was applied in the Port Resilience / Tactical Enforcement to Combat Terrorism ( PROJECT) and relied on a quantal response (QR) model which made a departure from the usual assumption of a perfect rational adversary (Mckeivey & Palfrey 1985)

Sandler & Lapan (1988) examined the US anti-terrorism policy of not negotiating or yielding to the demands of terrorists who have taken hostages ( US Department of State, 2002, p. xii ). The thinking was that terrorist benefit if their demands are not met and with nothing to negotiate for, they would stop the abductions. This logic looked flawed since the behind the scene negotiations through arms bartering was done as in the case of the "Irangate" affair to seek the release of three US citizens. It is crucial to know how terrorist choose their targets and the appropriate modeling of their preferences and the choosing of the appropriate deterrence to neutralize the situation.

Basuchoudary & Razzolini (2006) noted that assessment is made of predictions pertaining to misaligned profiling. These deviations are addressed by looking at the model consisting of the terrorist on one part and the government security agency on the other. The government agency (defender) would have to decide which persons looked likely to commit a terrorist act and thus would need to do more extensive search. The defender will have to be selective and consider the most reliable types of persons fitting their category while the terrorist group (attacker) decides on whom to send for the act based on demographics.

Heal & Kunereuther (2005) investigated the airline security system by looking at how agents inter depend and the result of this interdependence affecting the choices they make in adopting measures that will reduce risk. The interdependence security (IDS) feeds into the generation of negative externalities by failing to investigate protective measures relating to fire safety, computer network security and protection against theft.

Zhuang & Bier (2007) dwelt their efforts on a continuous attacker and modeled what steps the defender should take to make known whatever allocation of resources was available. The importance of counter

terrorism be it the options open to the defender in filtering out the desired information in the context of arbitrary disclosure and the choices the attacker had to make were considered.

Beir, Oliveros, & Samuelson (2007) interrogated the strategic interaction that exist between a defender and an attacker whose choice of target is not anticipated. Strategic deterrence is address with the view of either making it centralized or decentralizing it altogether.

## 5. GAME THEORY SKETCH

In a classic game theory setup it is usual to discuss what a two person non-zero-sum game is. Often the Prisoner's Dilemma example is appropriate.

The two players who commit a bank robbery and are in a heist. They get chased and apprehended by the police and are placed in separate cells.

The two robbers or players are pit against each other with the following terms. They are individually given the option to confess or deny the crime. The rule here is the prison sentence a player receives is dependent on the choice the other player makes. If player 1 confesses, and player 2 denies or is silent, player 1 would be set free and player 2 would receive a prison sentence of 10 years. If they trade places in their confessions the same holds true for player 1. However, if player 1 confesses and player 2 confesses they each receive a 4 year prison sentence. Finally if they both decline to say a word, they receive a minimum sentence of one year each probably for the speed chase (Sokolowski& Banks, 2009).

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Each player desires a minimum sentence and additionally, none has any information about what the other says. We can come up with this following analysis:

1. Supposed player 1 confesses to the crime and player 2 stays mum or denies, player 2 gets the 10 years sentence and player 1 is set free. If they both confess they receive a sentence of 5 years each.

2. Supposed player 1 is mum and player 2 confesses, player 2 is set free and player 1 receives10 years in the cooler. Now if player 1 confesses and player 2 keeps mum or denies, player 1 will be set free.

3. Supposed player 2 confesses and player 1 goes mum or denies, player 1 receives 10 years and player 1 is set free.

4. Supposed player 2 denies or remains mum and player 1 confesses, player 1 is set free and player 2 receives the 10 years sentence, and 1 year sentence if they both deny.

In both scenarios, the two robbers are better off if they make a confession as they are not made to know each others choice. This is illustrated in Table II

**PAYOFF MATRIX OF THE PRISONERS**

**Table IV**

| | | **Player 2** | |
|---|---|---|---|
| | | **Confess** | **Deny** |
| **Player 1** | **Confess** | (5, 5 ) | ( 0, 10 ) |
| | **Deny** | ( 10, 0 ) | ( 1, 1 ) |

Adapted from: Modeling and Simulation for Analyzing Global Events ( Sokolowski & Banks, 2009 )

**5.1 DESCRIPTION OF THE MODEL:**

For the purpose of this paper which dwells on the deterrence as a first line of action, the model is adopted from (Bier et al.2007). The two key players participating are an ATTACKER and DEFENDER. Two primary targets are defended by the defender and will be denoted as target P and target S.

Now the defender selects the deterrence levels for targets P and S. It is worthy to note that deterrence increases in cost as failure rate increases (Gkonis et al. 2009).

This translates into cost $D_i$ where $i = \{P, S\}$. For an attacker's event of failure ($f_i$) on any target of the two targets then ( 1–$f_i$) is the probability of success.

Event probabilities of Attacker on any of the two targets (P, S) Failure = ($f_i$), and Success = (1–$f_i$)

**5.2 ATTACKER'S PAYOFF:**

For payoff, L and H an assumption of $L_i = 0$, is made and $i = \{P, S\}$. Attacker preferences are ($H_P$, $H_S$) sets the tone for the attack and is not known by the defender. The attacker's distribution and density function due to the information asymmetry will be, Distribution function = $F(H_P, H_S)$ and Density function = $f(H_P, H_S)$ with a successful attack (Gkonis et al. 2009).

Cost for damage becomes HD*i*, and $i = \{P, S\}$. It is worth noting that the attacker's preferences ($H_P$, $H_S$) is not known to the defender.

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Resources to the defender is ( $D_P$, $D_S$ ) and $\pi_i$ is probability to launch an attack on $\{P, S\}$. This is not dependent on failure probability $f_i$ $f_j$ of the defender's resources ($D_P$, $D_S$ ).

Defender's strategies has pairs representation ($D_P(f_P)$, $D_S(f_S)$ ). The attacker's strategy viewed as binary has choice of strategy $_S(H_P, H_S, D_P, D_S) = \{0, 1\}$ .

For P attack s = 1 and S attack s = 0

Probability that P will have an attack is:

$$\pi_P(D_P, D_S\, s) = \int_{Hp} \int_{Hs} s\,(H_P, H_S\, D_P, D_S)\, f\,(H_P, H_S)\, dH_P\, dH_S \qquad (1)$$

Probability that S will be attacked is $\pi_S = 1 - \pi_P$

The attacker's payoff (what he desires to maximize) is:

$$U(D_P, D_S, s) = [s(.)\,(1 - f_P)H_P + (1 - s(.))(1 - f_S)H_S]\, f\,(H_P, H_S)\, dH_P\, dH_S \qquad (2)$$

*The defender's expected payoff* :

$$L(D_P, D_S\, s) = \pi_P(f_P)\, H_P + \pi_S(1 - f_S)\, H_S + D_P(f_P) + D_S(f_S) \qquad (3)$$

***Optimal Strategy of attacker:***

For the optimal strategy of attacker, we notice from (2) that maximum attacker's payoff s=1 only if

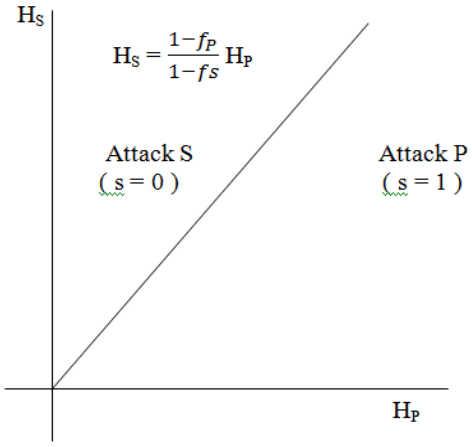
$(1-f_P)H_P > (1-f_S)H_S$ and s=0 if $(1-f_P)H_P > (1-f_S)H_S$ Let $s^*$, ($D_P^*$, $D_S^*$) be the equilibrium solution of optimal strategy of the two players involved.

For $s^*=1 \Rightarrow \frac{H_S}{H_P} < \frac{1-f_P}{1-f_S}$ and $s^*=0 \Rightarrow \frac{H_S}{H_P} > \frac{1-f_P}{1-fs}$

The attacker will choose a high value target if ( $1 - f_P$ ) = ($1 - f_S$)

However, if $\frac{1-f_P}{1-fs}$ has a value which is not 1, attack on P or S looks more certain to happen.

Now supposed that the target S is left undefended, then there is a 100% success rate for the attack on S and that makes s = 0 and $H_S > (1 - f_P)H_P$




Adapted from Bier et al. (2007) Attacker's optimal choice of target

***Optimal Strategy of the defender:***

For the defender's optimal strategy, ($D_P^*$, $D_S^*$) his payoff is minimized when the attacker's optimal strategy is $s^*$. An optimization problem ensue

$$\min L(D^*_P, D^*_S\, s) = \min[\pi_P(f_P)\, H_P + \pi_S \frac{1-f_P}{1-fs} H_S + D_P(f_P) + D_S(f_S)]$$

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$D_P$',,$D_S$

Conditions: First order

$\frac{\partial L}{\partial f_P} = 0$

$$\xrightarrow{\pi_S = 1-\pi_P} \frac{\partial \pi_P}{\partial f_P}(1-f_P)\,HD_P - \pi_P\,HD_P - \frac{\partial \pi_P}{\partial f_P}(1-f_S)\,HD_S + D_P'(f_P) = 0 \qquad (4)$$

$$\Rightarrow \frac{\partial \pi_P}{\partial f_P}[(1-f_P)HD_P - (1-f_S)HD_S] - \pi_P\,HD_S + D_P'(f_S) = 0$$

$\frac{\partial L}{\partial f_P} = 0$

$$\xrightarrow{\pi_S = 1-\pi_P} \frac{\partial \pi_P}{\partial f_S}[(1-f_P)\,HD_P - \frac{\partial \pi_P}{\partial f_P}(1-f_S)\,HD_S] - (1-\pi_P)\,HD_S + D_S'(f_S) = 0 \qquad (5)$$

$$\Rightarrow \frac{\partial \pi_P}{\partial f_S}[(1-f_P)HD_P - (1-f_S)HD_S] - (1-\pi_P)HD_S + D_S'(f_S) = 0$$

**5.3 DESCRIPTION OF THE GAME:**

According to Niels Bohr, when it concerns the future, it is very difficult to make a prediction yet humans tend to react once a prediction is known hoping that similarly others will so same (Sigmund, 2011). In the last couple of years, agent based systems have been used to address the problem of allocating the limited resources for the protection of vital infrastructure (Jain et al. 2010).

According to Lapan & Sandler (1993) safety and security show varied differences. In the context of safety, avoidable things that happen are not intentional while in security they are intentional. This makes it imperative to approach security quite methodically with decision making markers to ensure safety is enhanced. The decision markers are dual in the security setting. As one party the attacker, seeks to inflict the maximum damage, the defender from the other party tries to prevent any such occurrence from happening. The attacker and defender will have to adopt strategies based on how each party will react to a choice the other makes.

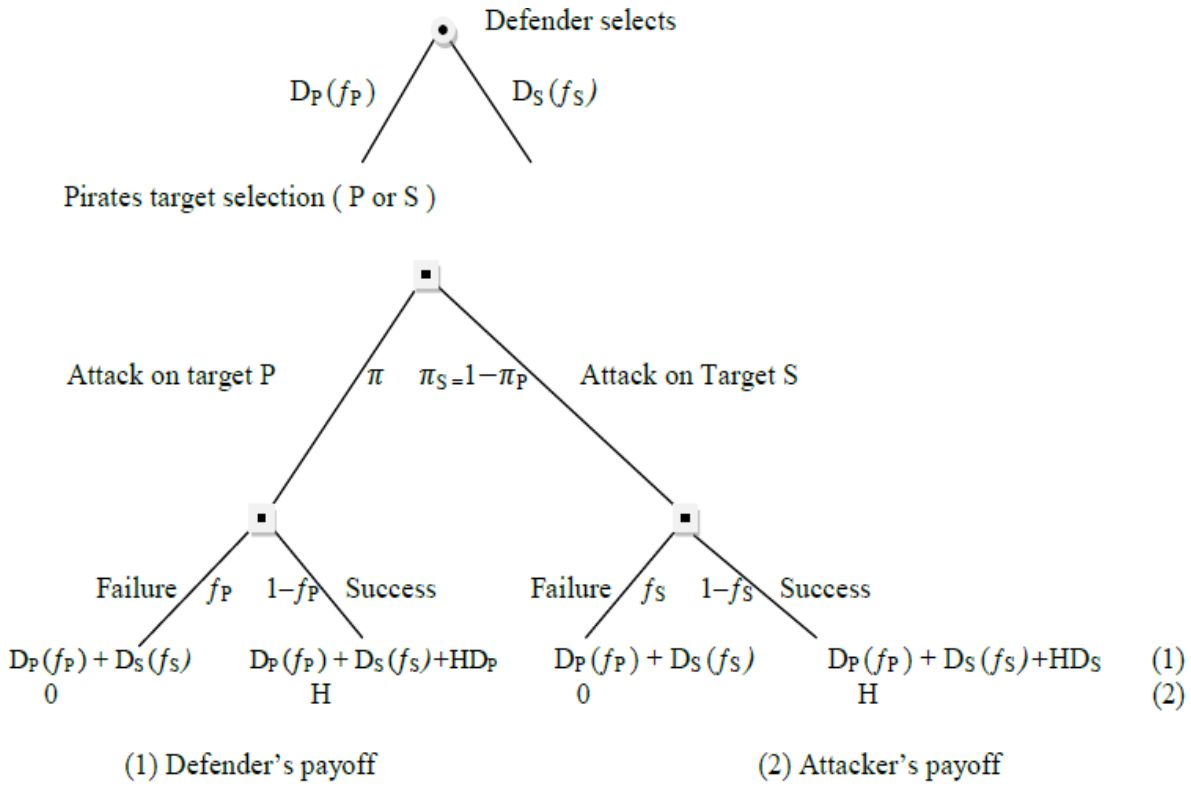


**FIGURE II GAME TREE OF THE ENCOUNTER**

Adapted from Modeling Security Aspects of Merchant Shipping Gkonis et al.(2009)

## 6. CONCLUSION

The 9/11 incident threw a challenge to security and brought to the fore the ingenuity of the adversary in using transportation as a terrorist weapon. This act culminated in the introduction of the International Ship and Port Facility Security Code (ISPS) which included both port and ship security. The threat posed to maritime transportation and security demands that critical attention is given to the lapses and that they are adequately addressed. The Gulf of Guinea is an integral part of the seaborne trade route. Discovery of oil in some of the littoral states has brought on board a surge in piratical activities along this corridor. Though extensive research has been channeled to the causes and drivers of this menace, little study has been done on the decision making aspect to curtail this. It will be an exercise in futility if the limited resources available to the navies traversing the Gulf of Guinea do not put into place a form of deterrence mechanism to augment their efforts. Maritime security is seen as a global challenge and game theory provides the necessary aspects to cause a paradigm towards adversarial decision making and allocation of security resources. In real case scenarios, a decision making model like game theory can be utilized as the setting is in a cooperative as well as a competitive setting or environment which ultimately provides us with an optimal choice. The counter measures deployed to fight piracy in the Gulf of Aden could have limitations when applied in the Gulf of Guinea. Togo, Benin and Nigeria do not allow Private Contracted Armed Security Personnel (PCASP) in their territorial waters and would rather prefer to engage their naval forces (International group, 2013). Finally, the GoG states should adopt a common strategy comprising of their navies to comprehensively tackle the various challenges of maritime security that bedevil the region.

## REFERENCES

[1] Abubakar, J. (2010). Oil: Ghana turns on the tap, Egypt to build refinery in Ghana. Daily Trust, 16 December, p. 19.

[2] Anene, L. (2006). 'Gulf of Guinea: A Growing Strategic Profile', Nigerian Army Quarterly Journal, 2(11): 39-51.

[3] Banks, J. (1998). *Handbook of Simulations: Principles, Methodology, Advances Applications, and Practice.* New York: Willey, 1998

[4] Basuchoudhary, A. & Razzolini, L. (2006). "Hiding in plain sight – using signals to detect terrorist", Public CHOICE, 128: 245-255

[5] Benkenstein, A. (2003). *West Africa: Gulf of Guinea - the New Flash print of Piracy in Africa?* Article retrieved online on January 18, 2014. from: http:/alllafica.com / stonics /201312171230.

[6] Bier, V., Oliveros , & S. Samuelson, L., (2007), " Choosing what to protect: Strategic Defence Allocation against an unknown attacker", Journal of Public Economic Theory, 9 (4), 2007, pp. 563 – 587

[7] Bridger, J. (2014). "Kidnapping Resurgent in Gulf of Guinea Piracy" USNI News, March 14, 2014 http:// news.usni.org/2014/03/14/kidnapping-resurgent-gulf-guinea-piracy. Retrieved online on March 20, 2016.

[8] Halberstam, M. (1998). "Terrorism on the High Seas: The Achille Lauro, Piracy and the IMO Convention on Maritime Safety", American Journal of International Law, 82:269 - 286

[9] ICG, (2014) Inter Nation Crisis Group www.crisisgroup.org /~/media/files/Annual%20Reports retrieved online on February 8, 2016.

[10] IMB, (2011) "Piracy and armed robbery against ships, report for the period 1 January – 31 December 2011, op. citi.

[11] IMO, (2002) The International Ship and Port Facility Security (ISPS) Code (Safety of Life at Sea, Chapter XI-2 ) International Maritime Organization, London.

[12] IMO, (2011) Unanimous Resolution 2018(2011) www.un.org/press/en/2011/sc10430.doc.htm Retrieved online on January 10 2016.

[13] IMO, (2014) http://www.imo.org/en/OurWork/Security/PiracyArmedRobbery/Pages/Default.aspx

[14] Jain, M., Kardes, E., Kiekintveld, C., Ordonez, F., & Tambe, M. (2010). Security games with arbitrary schedules: A branch and price approach. *In Proc. Of The 24th AAAI Conference on Artificial Intelligence.*

[15] King, R. O. (2008) Ocean piracy and its impact on insurance. Congressional Research Service. http:// fpc.state.gov/documents/organization/115925.pdf. Article retrieved online on March 16, 2016.

[16] Kunreuther, H. & Heal, G. (2003), " Interdependent Security," The Journal of Risk and Uncertainty, 26: 2/3; 231 – 249

[17] Lapan, H. & Sandler, T. (1993). "Terrorism and Signaling", European Journal of Political Economy, 9(1993) 383 – 397.

[18] Llyod's Market Association: www.Imalloyds.com retrieved online on January 10, 2016.

[19] Mckelvery, R. D. , and Palfrey, T. R. 1995. Quantal response equlibra for normal form games. *Games and Economic Behaviour 10(1) : 6 -38.*

[20] Mejia, M. Q. Jr. (2003). "Maritime gerrymandering: Dilemmas in defining piracy, International Commercial Law, 2(2): 153 – 175.

[21] Onuoha, F. (2010) Geo – Strategy of Oil in the Gulf of Guinea: Implications for Regional Stability. *Journal of Asian and African Studies*, 45 (3)p. 370

[22] Rubin. A. P. (1998).The Law of Piracy (2nd Ed), New York: Traditional Publishers.

[23] Sandler, T. & Lapan, H. E. (1988), "The Calculus of dissent: an analysis of terrorists choice of targets," Synthese, 76: 245 – 261.

[24] Sokolowski, J. A. & Banks, C. M. (2009). *Modeling and Simulation for Analyzing Global Events.* John Wiley & Sons, Inc 2009.

[25] United States Department of State, (2002). Patterns of Global Terrorism. Washington, DC: US

[26] Vircoulon, T. (2012), 'Pirates of the Guinean'. Foreign Policy, 20 December, Available at: <http: //www.foreignpolicy.com/articles/2012/12/20/pirates_of the_guinea?page=full>.

[27] Zhuag, J. & Bier, V. M. (2007). "Balancing Terrorism and Natural Disasters –Defensive Strategy with Endogenous Attacker Effort," Operations Research, 55: 5, 976 – 991.