# THE USE OF DRONES IN PORTS

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## ABSTRACT

The strategic importance of maritime security is a continental issue in Africa and very closely linked to its perceived successes and failures as a maritime continent. This is directly related to the porous nature of maritime crimes in the very fabric of Africa's maritime profile. This paper seeks out the questions that drive the continent into understanding the rationale behind deploying drones as a measure for maritime security and safety. It highlights the requirements of drones within a maritime safe and secure environment and indicates the technology challenges that exit around drones as an attempt to achieve such maritime safety and security. The most prominent application of drones as such a measure is reviewed in its base application against maritime environmental crime data collection tool. It clarifies the status of data so collected by drones as it relates to its *locus standi* in current legal systems. This is as the data so collected does not constitute to evidence gathered for detection purposes. This is further amplified by what such status would be in the process of port state control as part of port security and is expanded to cover the same application process for other maritime crimes than environmental. The paper is positioned to find a bridge between the data collected by drones and the application for such by the implementation of the Flag State Control and the ISPS Code. This is considered for the impact factors obtained by the implication of using drones as a deterrent for maritime crimes in its combatting and prevention role. The paper lastly considers typical deflection strategies implemented to contravene in the application of drones as part of port security.

## 1. STRATEGIC IMPORTANCE OF MARITIME SAFETY AND SECURITY

Maritime crimes, which are the corrosion of maritime safety and security is often directed at vessels or maritime structures (css.unodc.org), which find application in most of the piracy perpetration. However, this is not where maritime crime stops, it also includes the transportation of illicit substances or trafficking in persons by organized transnational criminal networks (css.unodc.org). This is in its violent forms, when it becomes a menace to the security of navigation, to the physical integrity and life of seamen and the preservation of vessels.

This changed in character when the awareness of the toxic fumes released by the very same vessel became identified as another inherent danger to maritime safety and security. The main types of fuel for vessels (bunkers as it is known by) is heavy fuel oil, and a residue of the distillation of crude oil. The presence of sulphur in the crude oil undergoes combustion in the engine and ends up in toxic ships emissions, a sort of silent, non-violent killer in some sense.

So drawing from the widely positioned maritime crimes to the closely experienced one is that of the very up and close personal impacts these emissions have on human health, such as respiratory symptoms and lung diseases.

From 1 January 2020, the limit for sulphur in fuel oil used on board ships operating outside designated emission control areas is reduced (www.imo.org), which will significantly reduce the amount of sulphur oxides emanating from ships and should have major health and environmental benefits for the world, particularly for populations living close to ports and coasts (seanew.co.uk).

In other words, sulphur emissions is now part of the basket of maritime crimes, being an environmental crime (UNEP (GEAS), 2013).

This brings about the question of how would such a maritime crime be detected, data collected, evidence gathered and due legal procedures followed to punish the crime?

## 2. 2020 GLOBAL SULPHUR GAP LIMIT

The International Maritime Organization (IMO) decided at its 70$^{th}$ session of the Marine Environmental Protection Committee (MEPC) in October 2016 to reduce the maximum sulphur content in the exhaust gas to air from 3.5% to 0.5% from 2020. It can be viewed as an extension – a globalization – of the regionally motivated Emissions Control Areas (Lindstand, 2017).

The implications of the international convention relating to the implementation of low sulphur content and how to combat it, is important for the goals the international convention is trying to achieve.

The IMO 2020 regulation implies that ships can continue to use sulphur-rich fuels by vessels using exhaust gas cleaning systems (scrubbers). The function of scrubbers on a seagoing vessel is to use seawater to wash out the sulphur in the exhaust gas. It firstly aims to achieve cleaner air by dropping the sulphur content in the bunker fuel of the vessels.

Then it aims to have a positive impact on human health for which any deterrent in this regard will have to function from a baseline. Its third aim is to have higher quality fuels deployed on vessels, the implication of this is that refineries will have to change their quality standards in their bunker fuel that most probably will have some cost implications for ship owners and operators as well (Luttenberger, 2010).

These aims will be achieved by the change management now required by Flag and Port State control to make sure vessels are compliant. Part of this change management, is to explore the utilization of drones as a deterrent.

The development of drones as a possible deterrent to the commitment of the environmental crime of sulphur content in the plumes of smoke released by vessels, is largely coming from the design advancements made in the area of drone development.

The basic problem behind using drones for tasks too onerous for humans, was driven from its weight and the power of its batteries and electric motors. This still plays a large role in its deployment today as it is now its payload that triggers its endurance for weight and power.

## 3. DRONES AS A DETERRENT FOR MARITIME SAFETY AND SECURITY

Drones are robots which include unmanned air vehicles (UAVs) that fly thousands of kilometers and small drones that fly in confined spaces (Krijnen, 2014; Cavoukian, 2012). Aerial vehicles that do not carry a human operator, fly remotely or autonomously, and carry lethal or nonlethal payloads are considered as drones (Guptha et al., 2013).

To use drones as a deterrent for a maritime environment crime, the relevant authorities will have to development a framework for implementation purposes.

First off, the drone operation has to be licensed with flight paths and patterns approvals, especially around the port entrance area and within the port area. The decision for singular or multiple drone deployment would very much depend on the purpose the drone will be deployed in the first place.

It comes from the fact that drones have dedicated flown radius from people and congested areas, residential areas and open-air assemblies. Part of it is also that a visual line of sight that may be direct and unaided contact be of importance. There has to be a consistent monitoring of flightpaths in relations to other aircraft and persons on ground. Provision in this framework must also include emergency flight measurements for safety purposes and includes features for flight interruptions and pre-determined off veer locations.

Electronic identification is an important provision as it would allow for remote accessing of information to assess legitimacy and threat status. This opens a whole new area of drone deployment. The ability to access drones or to deploy them for malign purposes, play a huge role in how control of the drones would be structured.

Drone pilots and control stations will have insightful impacts on the human resource elements of the relevant authorities. Pilot training allows for development of new skills, which will contribute rather positively to the skills levels of the communities of the affected ports.

Control stations may source form of local employment centres and direct investment in the same communities.

Automation cuts out business and human operational risks, enhance data accuracy and 24/7 availability, leaving the task of data analysis to humans, allowing thus for increase in employment capital. This leaves room for the question of interfacing data platforms between drone software and application node software for translation into operable integration platforms.

Drones' biggest contribution may be to move from manual inspection tasks to drone inspection tasks which will heighten know-how economies reach.

## 4. DRONES TECHNOLOGY CHALLENGES

Various types of drones can be introduced by taking inspiration from nature (Hassanalian, 2017).

It should be noted that, despite the progress in drone technology, there are some gaps in their design. One of the important tasks in the design process of all types of drones is

sizing which results in the optimum values of their dimensions and weights (Hassanalian, 2017).

The sizing process of drones is usually composed of five steps:
1. Defining the mission.
2. Setting the flight mode based on the type.
3. Determining the wing shape (planform) and aspect ratio.
4. Constraint analysis.
5. Weight estimation (McMichael, 1996).

In the definition of the mission, the analysis of the route is conducted resulting in the determination of the flight time, cruise speed, and turning speed (Hassanalian, 2017).

After that, the determination of the flight modes, shape of the wing and its aspect ratio are determined based on the type of mission (Hassanalian, 2017).

Radio Frequency is tracking only efficient if drones are conventionally flown. GPS is hard to track as no remote control element to monitor will be present and the same if the drone has on-board intelligence. Coordinated drone swarms allowing multiple drones collectively flown into a given area, negates single detection sources, opening possibilities of drones falling in to the trap of being diverted from its legitimate course. Flying drones individually, with line of sight only, brings a surveillance payload limitation as the cost of sensors range from low, optical cameras to very expensive for infra- red cameras, if the payload for the drone is configured in that manner.

Data gathered by drones cannot be used in a criminal court case as stand-alone prima facie evidence. It can be used to pinpoint which vessels' fuel tanks to get samples from, as plumes of smoke disappear, so data collected from it in real-time only lead to follow for emission testing of fuel tanks. This data must be providing a means to gather data to justify more detailed inspection. Sequentially directed action deployment should led from Data Collection to Evidence Gathering for Detection purposes.

Only on that basis may a case be built for the establishment of a maritime environmental crime for which a fine may be issued.

## 5. SUITABILITY OF DRONES OPERATIONS WITHIN AN INTERNATIONAL LEGISLATIVE ENVIRONMENT

Drones currently have three drivers, namely; its primary driver, which is that of pollution combatting, its secondary driver, which is that of marine governance and its tertiary driver being that of carry-carrying for search and rescue missions.

Drones can find application for offshore pollution monitoring capability (Oil and Fumes) where it may possibly linking the data/information directly to Maritime Domain Awareness systems for real time information. It may play a role in Search & Rescue application with the development of cargo-carrying drones, equipped with deflatable rescue equipment.

Vessel Inspection drones where using intrinsically safe drones, allowing safety surveyors to survey vessels, which will include tanks inspections as well as other damage assessments. Small Sniffer Drones for in-port to take samples of any fumes to determine compliance with Low Sulphur Emission requirements. A further application of drone suitability lies in the possible development of oil sampling drones (CSO, 2020).

## 6. REQUIREMENTS OF DRONES OPERATIONS

Infrastructure for drones requires land availability that is enough for having hangars space, where maintenance, replacements and repair facilities may be located.

Provision should also be made available for Drone Control Stations.

Area of operations for the drones would be typically for the short to medium term both within the 12 NM Zone and within the Port Area.

Technical requirements of the drone would be, regardless of who develops the drone, complicated by the marine environment. This will inevitably add additional complexity to designs and may lead to the solving of a number of technological challenges. Here are a few potential “technical hurdles” that may need solving along the way, such as performance where vast flight areas and extended flight ranges are covered. This requires long endurance/persistence and communications ranges and related technology (e.g. SATLINK for BRLOS operations). This also requires a fast time-to-target (e.g. Maritime SAR and disaster support) where performance in during periods of strong wind and low ambient temperatures (icing conditions) are required to suit the environment.

It does not exclude special abilities, such as ship-borne operation (storage, handling, take-off, recovery), or special propulsion requirements/arrangements (confined to ship-borne operations). Its durability, reliability and dependability as it relates to corrosion resistance for the marine environment, its weather tolerance to moisture, sea salt, gusts, rain, low temperatures, must be made provision for in its quality of design, components and assembly. This is vital to allow system availability and dependability for critical tasks, e.g. SAR, disaster support, security, etc.

When reviewing the requirements for payload performance, it may be task-specific such as custom payloads, or marine-optimised for performance in a marine environment as well as marine-hardened in its durability and reliability.

Using one drone only for a specified mission can be risky because the drone may encounter some technical or other problems, but various missions can be performed with more efficiency by applying multiple drones.

Therefore, nowadays due to advances in communication, intelligent software, and processing power, the swarm flight of drones is considered as one of the important topics in drones’ studies. Swarm intelligence is a novel field of bio-inspired artificial intelligence based on the behavioral models of swarm flight of birds and insects, such as ants, bees, wasps, termites, etc. (Roy et al., 2014).

A swarm flight of drones has an advantage, if one drone of the swarm is lost in flight, the rest of the drones can carry out the mission. Also, in swarm flight, a combination of various types of drones with different sizes and configurations can make a formation flight (Hassanalian et al., 2017).

## 7. WHAT WOULD BE A DRONE TARGET?

Drones may have the target to combat the avoidance by shipping lines of purchasing more expensive fuels. Bunker fuel single most expensive input factor of operating costs, and is

due to becomes more expensive to adjust it to lower shipping's emissions of sulphur oxides.

Emissions of bunker fuel is air pollution and it does not have boundaries, it just flows around. Drones may scan plumes of smoke created by vessels and collect real-time data testing for sulphur in vessel's fuel. These scans are enabled by having sensors as the payload in the drone that are integrated with a database designed for recognition, identification, measuring and capturing.

Authorities can use drones to effectively filter through the tens of thousands of vessels coming in and out of their ports. Knowing in advance if a ship is burning non-compliant fuel means they can target the right carrier for a manual inspection.

## 8. POTENTIAL OUTPUTS OF DRONES

To obtain optimum value for the investment of a drone fleet, would include outputs of indicating real time relay and the storage of footage gathered. It would be expected that the outputs are image-based, and will have a presence in all eight commercial ports of South Africa. Another output would include the ability to vertical take-off on vessels and have an underwater capacity together with a fumes "sniffing" capability.

The "sniffing" implies an aerial requirement to remain in Live Feed mode, which will make the actual purpose of data gathering and analysis possible.

## 9. ORGANIZATIONAL CHANGES TO ACCOMMODATE DRONES

Drones would require Change Management to include Drone Data Gathering in Data Analysis as part of standard operating procedures and business processes.

The changes in the Standard Operating Procedures to accommodate Drones as an Input Factor would require the adaption of systems alignments, platform configurations, network requirements and server capacities.

Financial provision for the Drone Fleet Acquisition, Maintenance and Replacements as well as its Control Stations, should be part of the strategy of the relevant authority. This strategy has be included as part of a long term plan the authority has in place for the execution of the duties within the maritime safety and security domain. This does imply that budgetary provisions for Updates and Upgrades made to the Drones and their Payloads should be projected with as short as possible time frames due to the inherent quick obsolete nature of the technology both as hardware and its payload software.

The most critical Change Management aspect of implementing drones into relevant authorities is its impact on its human resources, which includes the broad span of the organization itself. The addition of brand new skills such as drone pilots will form part of the organization and the control center behind them has to include its data mining resources and integrated links with external but related organizations.

## 10. THREATS TO DRONES: CYBER SECURITY

Cyber security contains to a very large extent an inclusion of the realization that the problem normally lies between the keyboard and the chair in other words; the human sitting in the chair operating the computer. This brings in the element of human testing,

which is frowned upon as constitutional rights comes into play and a profound acceptance has to be made that humans are what makes a network, any network function.

Contingencies have to be built-in, maintained and upgraded continuously to ensure hardware reliability.

It should also expands to having an independent secure overriding capability in emergencies as well as a strict layout of what such emergencies should curtail. From a hardware perspective, it may even be required to have the actual drone custom-build together with its payload to allow a smaller pool of error fact finding in events where things went south.

As drones are acting just as an enabler between what its payload observe and what the software captures of it software integration with firewalls and blocked of cell locations may be a good strategy to develop in protecting the data itself. This allows then for platforms integrity authorization levels where the consideration of Blockchain operating processes for operational purposes through communication links may be pursued. It has the potential of being extended into network and server infrastructure and channels

The important part of cyber security is that the access to benign information as a custodian organization may be disseminated for malign intent.

## 11. DRONE TARGETS: EXPANSION FROM MARITIME ENVIRONMENTAL CRIMES TO MARITIME SECURITY CRIMES?

The question becomes now that if Drones can be equipped to “sniff” for Sulphur content by linking a database as payload to the drone software platform, the payload may be adjusted for other “sniffs” than Sulphur.

Sniffing for Sulphur makes provision for the inclusion of microscopic particles present in plume of smoke. Presence of specific particles and its concentration levels in plume of smoke “sniffs” presence of sulphur, runs its content algorithms and release a hit of percentage indicator. Current development for identification of volatile organic compounds, fine-tuned to microscopic particles released commonly in the transport of organized crime products. In other words, smell or “sniffing” becoming an input factor into crime combating.

This is achieved by classifying the different microscopic particles present in different physical environments of different maritime crimes. Allowances for variances in concentration levels should be made to indicate as increased hit ratio of presence. This has the potential of pinpointing to “grid-level” specific locations.

The advantage is of it is direct detection, lower investigation costs, lower inspection man power and increase investigation effectiveness.

## 12. MARITIME CRIMES – TRANSNATIONAL AND INTERNATIONAL CRIMES

The United Nations Office on Drugs and Crimes, incepted only in 2009 with a limited staff and a small accumulated budget of only around $127 million up to now, is formed to play a supporting role on a global scale for the combatting, one almost want to neglect to say prevention, of maritime crimes.

This office is tasked to provide direct support to coastguards, prosecutors and other criminal justice partners, by using the latest maritime domain awareness technology to detect and detain maritime transnational or international crimes.

It is also tasked to provide skills to make arrests and assist for fair and efficient trials for such crimes, however their capabilities seemingly restricted by not including evidence gathering explicitly, so investigating powers have scope for broadening.

At a guestimate, on average, around 3-5% of all world cargo are inspected in ports, predominantly USA and China, based on economy-related importance, where vessels inspections by port state control, takes place under ports authorities' jurisdiction.

The procedures for Port State Control happen in accordance with IMO Port State Control Procedures, where cargo inspections happen on the basis of presentation of documentation related to the goods in advance. The gap lies between the two where port inspections of vessels has to be done in line with target factors of inspections and within time periods elapsed since last inspection. Ships' inspections itself, are limited to conditions of a ship, its equipment or crew thereof.

So for areas of maritime safety, marine environment protection and seafarers' living and working conditions, a more detailed inspection during a ship's inspection should be allowed. If during an inspection, a more detailed inspection or an expanded inspection deficiencies hazardous to human life, safety, other ships or environment have been discovered, the Port State Control Inspector may detain or stop the operation. This may be contested, however such contestation shall not suspend detention.

As a means of Inspection, the positioning for drones to be used based on difficult-to-reach areas and camouflaged operations is currently presumed to be illegal, however deployment may be triggered by pilots observing potential investigation areas using human eye/ intelligence.

## 13. DRONES BRIDGING THIS GAP?

Smell is a human sense ("sniff") and has an inherent Reliability factor difficulty as it may be subjective of nature, triggered by a memory or may be short term lasting.

However smell is microscopic particles making contact with human nostril hair that are impacted by direction and strength of wind. By rebuilding it into an outsourcing of mundane human activity into a highly accurate and quantifiable measure to combat maritime crimes it may be shifted from "sniffing" for sulphur into "sniffing" for other maritime crimes.

These crimes include human trafficking through toxic human waste fumes, armaments smuggling or weapons of mass destruction through gun oil and residue as well as drug smuggling through the chemical compounds released by the illegal substances.

This is possible as all substances release fumes consisting of microscopic particles in the air at different concentration levels, some easily detected, others not. So by configuring a drone's payload to detect these compounds, an attempt may be made in combating these crimes.

However, it is important to note that this is deemed as data collection and not evidence gathering, but detection may now take place by identifying specific locations where fumes are dispersed as inspection areas.

## 14. IMPLIED RECOMMENDATIONS OF DRONES ON PORTS

Drones in ports would firstly create the opportunity to build Case Law for inclusion of drones deployed with port areas as part of Port State Control inspections, especially when detentions are contested. At the same time, it would build socio-economic impact cases for combat and prevention of maritime crimes with the aid of drones, by leveraging from used-case studies. It may very well set new precedents in the gathering of prima facie evidence.

A next step for the implications of drones in ports would be to integrate MoU status of Flag States of ships with active implementation of drone-led inspections. It may even have the potential of playing a role in strengthening the Flag State Control Conformance Index (FLASCI) of Flag States' ships' registers.

The deployment of drones will necessitate an expansion on regulations for drone-led inspection as part of Standard Operating Procedures for pilot observation on board of ships as part of ISPS. The International Ship and Port Facility Security (ISPS) Code is an amendment to the Safety of Life at Sea (SOLAS) Convention (1974/1988) on Maritime security including minimum security arrangements for ships, ports and government agencies (www.imo.org).

Having come into force in 2004, it prescribes responsibilities to governments, shipping companies, shipboard personnel, and port/facility personnel to "detect security threats and take preventive measures against security incidents affecting ships or port facilities used in international trade."

Drones will straddle unclear defined jurisdiction lines for inspections, leading to detection and evidence gathering for investigations for results in arrests and trials. It does mean that frameworks need to be develop for drone inspections that will overarch international conventions, continental charters and national legislation.

Another recommendation would be to upfront apply drone fleet infrastructure development, operational development and foundation organization, in all its aspects to form a coherent framework from which actions and tasks may be derived. This will add in the element of developing institutional cooperation alignments across international, continental, regional and national prevention and combat organizations.

## 15. DEFLECTION STRATEGIES AS CONCLUSIONS FOR THE USE OF DRONES IN PORTS

Drones came about as a military strategy for surveillance and reconnaissance and went down a sliding elevator from deadly force to a toy for entertainment value. So the actual image of the drone has received a bit of a hit in between these variants.

One may view this as building an invasive and intrusive image of drones, open for public domain bashing and political argument development, just on the basis of the deployment of drones on moral grounds. The fact of the matter is unfortunately that conduct may be legislated but not moralised under a civil society's judicial system.

Another deflection strategy that may be developed is to administratively discourage the deployment of drones through the development of exceptional bureaucratic requirements for drones. This may find itself a handy political lobbying tool which may be used to play a role in the resistance privacy matters offers into “eye in the sky” surveillance and the dangers thereof.

Lastly, a disregard for licensing and operations requirements for drones by tightening the application and implementation of drone owning and operating requirements, an active role is played in “choking” the markets for the applications of drones.

Implementing a restricted research focus may be a good strategy to undermine the safety and security optimization role drones can play, which may be aided with weak maritime crime jurisdictions evasions leaving room for corruption and collusion.

The legal and regulatory restrictions placed by the state may create an avoidance of drone deployment as a safety and security measures.

By using time released fumes confusion may be created regarding the readings from the data collected by the drones during deployment. This will lead to jurisdiction and validity disputes, especially if not properly incorporated into ports state control procedures, inspections have the potential to be argued.

The possibility of cyber security attacks for both hardware and software attacks for destabilizing drone-led safety and security platform, cannot be overemphasised.

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