"Successful practices in regulatory frameworks and regulations against the use of aerial drones for criminal purposes in ports: cases of Argentina, Brazil, and Mexico."

EXECUTIVE SUMMARY

Ports are critical and vulnerable infrastructures, where drones have been used for smuggling, drug trafficking, and other threats. Although some countries have made progress in regulating the use of drones in port facilities, many regulations remain insufficient. Given the increasing use of drones for legal and illegal activities, it is essential to develop effective regulations to mitigate risks. This article examines some aspects of regulatory frameworks and regulations that have led to successful practices in preventing the criminal use of drones in ports in Argentina, Brazil, and Mexico.

CONTEXT

In recent years, the use of unmanned aerial vehicles (UAVs), commonly known as drones, has experienced significant global expansion. Although initially conceived for military, recreational, or commercial applications, drones have been quickly adopted by organized crime due to their accessibility, low cost, and high capacity for remote operation. This phenomenon has generated new security threats, particularly in port environments, where high-value trade flows are concentrated and there is a complex interaction between public and private actors.

Ports represent critical infrastructure for national and international economies and are key hubs for global trade, but they have also become strategic locations for criminal activities such as smuggling, drug trafficking, industrial espionage, and, in extreme cases, attacks using drone-launched explosive devices.

The proliferation of drones has transformed industrial sectors, but it has also been exploited by organized crime, especially in ports, which, as critical hubs for international trade, are vulnerable to new forms of drone-facilitated crime, such as illegal surveillance, smuggling, and attacks.

These threats have exposed significant shortcomings in existing regulatory frameworks, most of which did not address the malicious use of drones in their original designs.

Faced with this reality, countries such as Argentina, Brazil, and Mexico have begun to develop more specific regulatory frameworks and implement regulatory, technological, and operational measures to counter these threats. Each presents distinct contexts, both in the criminal use of drones and in their levels of institutional response, which allows for a useful comparative analysis to identify good practices that can be replicated in other countries.

This article provides a brief analysis of regulatory frameworks, regulations, and successful practices against the criminal use of drones in ports, with the goal of contributing to strengthening port safety and security. Robust regulatory frameworks, efficient operational protocols, and cooperation mechanisms with effective regulatory and operational tools strengthen port safety and security. Similarities, differences, successful practices, and opportunities for improvement in port safety and security will be identified. Based on this analysis, recommendations will be made for the improvement, harmonization, and effective implementation of regulatory frameworks and regulations.

ANALYSIS BY COUNTRY

I. Overview of the Criminal Use of Drones in Argentine Ports.

In Argentina, the criminal use of drones in port environments is an emerging but growing threat that has begun to attract the attention of security authorities and airspace regulatory institutions. Although not yet at levels as sophisticated as those in Mexico or Brazil, the incidents detected reveal a growing trend in the use of drones for illegal activities associated with smuggling, criminal surveillance, and operational interference.

Observed Criminal Modalities:

- **Pre-reconnaissance of facilities:** Criminal groups use drones to map port infrastructure, observe personnel movements, and detect blind spots in surveillance.
- **Selective smuggling:** Use of drones to extract or deliver small, high-value cargo (confidential documentation and / or merchandise) before or after official inspections.
- **Remote coordination of illegal operations:** Drones allow activities to be directed from points outside the port, avoiding the use of communications that could be intercepted.

Ports with the greatest exposure:

- Port of Buenos Aires.
- Port of Rosario.
- Port of Bahía Blanca.

These ports are vulnerable to criminal operations at the regional and international levels.

Current Regulatory Framework:

- Decree 663/2024 regulates the general use of drones in the country, requiring registration and operating conditions. https://www.argentina.gob.ar/normativa/nacional/decreto-663-2024-401986/texto
- There are no specific regulations focused exclusively on port environments or criminal uses, although debates in Congress and sectoral efforts have begun.
- The Argentine Naval Prefecture has begun implementing monitoring and response measures, although still with limited technological capabilities.

Institutional Response Capacities:

- In Argentina, the main institutions involved in port security and protection are the Argentine Naval Prefecture, the General Administration of Ports (AGP), and the National Agency of Ports and Navigation (ANPyN). The Argentine Naval Prefecture is the authority enforcing the ISPS Code and responsible for maritime security, while the AGP is responsible for safety, hygiene, and the environment in ports, including emergency management. The recently created ANPyN is responsible for the administration of the main waterway and the enforcement of laws and regulations related to ports and navigation.
- Incident response is reactive and depends on the resources available at each port, creating an operational gap in the face of potential threats, facing technological and budgetary limitations to detect, track, and neutralize drones.

Main Challenges:

- Absence of specific protocols for incidents involving drones.
- Insufficient technological capabilities for early detection.
- Lack of regulatory harmonization between aeronautical, customs and security authorities.
- Little investment in anti-drone technologies.

Argentina is in an early but critical phase of the criminal use of drones in its ports. Although there are general regulatory measures and some institutional efforts, a more integrated, specialized, and technological response is needed to effectively confront this evolving threat.

In Argentina, port security addresses the drone problem through a combination of technology, regulation, and collaboration between different agencies. Detection systems and, in some cases, inhibition systems are used to protect critical facilities. Current regulations seek a balance between the recreational and commercial use of drones and the need to protect sensitive areas such as ports.

Measures and technologies used.

- **Detection systems:**

Drone detection technologies, such as radars and sensors, are being deployed to identify the presence of unmanned aircraft in restricted areas.

- **anti-drug systems:**

In some cases, systems that can inhibit or neutralize unauthorized drones, such as jammers or anti-drone rifles, are used.

- **Regulation and control:**

The General Port Administration (AGPSE) establishes specific regulations for the use of drones in port areas, requiring permits and restrictions for certain activities.

- **Surveillance and patrolling:**

Drones are used for surveillance inside and outside ports, both for patrolling and for vessel inspections.

- **Inter-institutional collaboration:**

Port security involves collaboration between the AGPSE, security forces (police, gendarmerie) and other government agencies.

- **Training and awareness:**

Training is provided to drone operators and security personnel to encourage responsible use and identify potential threats.

- **Implementation of video surveillance systems:**

The combination of CCTV (closed-circuit television) systems with drones allows for more comprehensive and efficient surveillance.

Challenges and perspectives:

- **Balance between security and freedom:**

A balance must be found between the need to protect critical infrastructure and allowing the legitimate use of drones.

- **Technological evolution:**

The rapid evolution of drone technology requires constant adaptation of safety measures and regulations.

- **International cooperation:**

Collaboration between countries is important to address cross-border problems related to the misuse of drones.

In summary, port security in Argentina addresses the problem of drones through a combination of advanced technology, specific regulation, surveillance and patrolling, and collaboration between different agencies, seeking a balance between security and the responsible use of this technology.

II. Overview of the Criminal Use of Drones in Brazilian Ports.

Brazil, with the largest port infrastructure in Latin America, faces a high and advanced risk of criminal drone use in its ports. The country has recorded multiple incidents where these devices are used by organized crime to facilitate illicit activities, particularly those related to international drug trafficking, smuggling, and interference with port security systems.

Observed Criminal Modalities:

1. **Rip-on / Rip-off:** (Container Scam / Unhooking) Use of drones to identify target containers and intervene in them to hide or extract illicit merchandise.
2. **Drug transport:** Drones used to transport cargo from land to anchored vessels, evading customs controls.
3. **Electronic jamming:** Use of drones equipped with jamming devices to block or disrupt surveillance cameras and sensors.
4. **Operational espionage:** Surveillance of police operations and movements of authorities, to alert accomplices.

Ports with the greatest exposure:

- Port of Santos.
- Port of Paranaguá.
- Port of Río de Janeiro.
- Port of Itajaí.

These ports are key to Brazilian foreign trade and can be infiltrated by criminal networks operating regionally and internationally.

There is currently no verified data on incidents involving drones used for criminal purposes at the ports of Santos, Paranaguá, Rio de Janeiro, and Itajaí. This suggests that, although the potential threat is high, there is no public evidence to date of drones being used in criminal operations at these ports.

Current Regulatory Framework:

- Regulation RBAC-E No. 94 of the National Civil Aviation Agency (ANAC), which establishes standards for drone operation. https://www.anac.gov.br/en/drones/files/rbac-e-no-94-amdt-00-english.pdf
- The Department of Airspace Control (DECEA) has delimited no-fly zones over strategic port areas, to restrict unauthorized flights in sensitive areas and apply sanctions.

Institutional Response Capacities:

- In Brazil, several institutions play crucial roles in port security. The National Water Transport Agency (ANTAQ) oversees all ports, while the Ministry of Ports and Airports (MTPAC) and the Federal Police work together to protect critical infrastructure. In addition, the Brazilian Maritime Authority oversees activities in Brazilian waters.
- Port security is the responsibility of several institutions, including the National Water Transport Agency (ANTAQ), the Federal Police, and the Maritime Authority. In addition, local port authorities and port companies also play a crucial role in security management.
- The Federal Police has implemented specialized anti-drone units in critical ports, with capabilities for detection, identification, and neutralization.
- Radar, radio frequency detection, and electronic countermeasures systems have been deployed at some high-priority ports.
- Brazil leads the region in technological response and institutional coordination against aerial threats.

Main Challenges:

- Coverage is still partial: Measures are concentrated on the main ports, leaving other logistical points vulnerable.
- Institutional interoperability: Need to improve coordination between the National Civil Aviation Authority (ANAC), the Department of Airspace Control (DECEA), the Federal Police, customs, and local authorities.
- Continuous training: Threats evolve rapidly and require constant training of operational and technical personnel.

Brazil is positioned as the country with the most advanced and structured response to the criminal use of drones in port environments. However, the size of its port system and the sophistication of organized crime require an expansion of technological capabilities, territorial coverage, and strengthening of inter-institutional cooperation.

In Brazil, port security and drone protection are being addressed through a combination of regulation, technology, and cross-agency collaboration. The National Civil Aviation Authority (ANAC) sets the standards for drone use, and local and federal agencies work together to detect and mitigate potential threats.

Regulation and Standards:

- **ANAC:**

ANAC is the main regulatory body for drones in Brazil, establishing standards for the registration, operation and safety of these devices.

- **Mandatory Registration:**

Drones weighing more than 250 grams must be registered with ANAC, following a common practice in many countries.

- **Restricted Areas:**

Restrictions apply to drone flight near airports, government facilities and other sensitive areas, similar to regulations elsewhere.

Technology and Security Measures:

- **Drone Detection:**

Drone detection technologies are being deployed to identify unauthorized aircraft in sensitive areas, such as ports.

- **Countermeasures:**

Countermeasures are evaluated and developed to neutralize hostile or dangerous drones, which may include disrupting signals, blocking communications, or using nets to capture them.

- **Interagency Collaboration:**

Local and federal law enforcement agencies are working together to respond to drone incidents and enforce regulations.

Other Aspects:

- **Search and Rescue:**

Drones are also used in search and rescue operations in ports and coastal areas, providing an aerial view to locate missing or distressed people.

- **Surveillance:**

Drones can be deployed for aerial surveillance in port areas, helping to prevent illegal activities and ensure security.

- **Training and Awareness:**

Training programs are being conducted for drone operators and security personnel to promote responsible use and compliance with regulations.

In summary, port security in Brazil is strengthened through regulation, the use of detection technology and countermeasures, and interagency collaboration to address potential threats posed by drones.

III. Overview of the Criminal Use of Drones in Mexican Ports.

Mexico faces the most complex and sophisticated scenario regarding the criminal use of drones in port environments. Mexican criminal organizations have extensively incorporated this technology for various illegal activities, including drug trafficking, intimidation, espionage, and direct attacks on critical infrastructure. The geographic proximity to the United States and the activity of technologically advanced cartels have accelerated the evolution of these threats.

Observed Criminal Modalities:

1. **Cargo surveillance:** Drones are used to track containers from unloading to storage or departure from the port.
2. **Intimidation of port personnel:** Drone flights have been documented to film and monitor employees and their families, for the purpose of pressure or threats.
3. **Narcotics Transportation:** Modified drones with greater payload capacity are used to transport drugs between ships and land-based locations in urban areas.
4. **Explosive attacks:** Isolated cases of drones equipped with improvised explosive devices have been used to destabilize operations or eliminate targets.

Ports with the greatest exposure:

- Port of Manzanillo.
- Port of Lázaro Cárdenas.
- Port of Veracruz.
- Port of Altamira.

These ports are key hubs for Mexican foreign trade, but also strategic points for transnational drug trafficking and smuggling networks.

Current Regulatory Framework:

- Circular CO AV-23/10 R4 of the General Directorate of Civil Aeronautics (DGAC), which regulates drone operations, although its implementation has been limited in ports. https://www.gob.mx/cms/uploads/attachment/file/603112/co-av-23-10-r4_.pdf
- In 2024, the Federal Penal Code and the Federal Law on Firearms and Explosives were amended to criminalize the use of drones for criminal purposes, with penalties of up to 53 years in prison. https://www.diputados.gob.mx/sedia/biblio/prog_leg/Prog_leg_LXV/258_DOF_07jun24.pdf
- Despite legislative advances, its practical application remains partial and subject to interpretation in operational environments.

Institutional Response Capacities:

- In Mexico, the institutions responsible for port security are primarily the Secretariat of the Navy (SEMAR), through the Port Authority and Maritime Affairs Unit (UNICAPAM), and the National Port System Administrations (ASIPONAS). SEMAR, as the National Maritime Authority, is responsible for maritime regulation and surveillance, including port security. ASIPONAS, for their part, are responsible for the management and operation of concessioned ports, including security aspects.
- The Secretariat of the Navy (SEMAR), responsible for port protection, has begun implementing drone detection and neutralization systems in key ports.
- There are pilot initiatives with radars, signal jammers and thermal surveillance, but coverage is limited and depends on the perceived threat level.
- Mexico shows a reactive response, still in the process of systematization and standardization.

Main Challenges:

- Internal corruption that weakens control capabilities and facilitates information leaks.
- Uneven application of regulations depending on the port or region.
- Budgetary and technological limitations to expand anti-drone systems.
- Constant adaptation to organized crime requires continuous improvement of response capabilities.

Mexico faces the most sophisticated and diverse threat in the criminal use of drones in ports. While there have been important legislative advances and institutional efforts led by SEMAR, the evolving nature of the problem demands a comprehensive national strategy with a preventive, coordinated, and technologically robust approach.

In Mexico, port security and protection against drones is addressed through a combination of regulation, technology, and cooperation among various authorities. Port authorities, in coordination with the Federal Civil Aviation Agency (AFAC) and other entities, implement measures to prevent the misuse of drones in sensitive areas such as ports.

Measures and actions:

- **Regulation and permits:**

The AFAC issues regulations for the use of drones, including the need for registration and permits to operate near sensitive facilities such as ports.

- **Detection and countermeasure technology:**

Drone detection systems are implemented to identify unauthorized aircraft and, in some cases, systems to counter their operation, such as signal inhibitors or interception systems.

- **Surveillance and monitoring:**

Constant patrols and monitoring of airspace near ports are carried out to detect suspicious activities.

- **Interinstitutional coordination:**

Collaboration between port authorities, AFAC, the Navy and other entities is encouraged to share information and resources.

- **Risk analysis:**

The specific risks associated with the use of drones in each port are assessed, allowing for the design of customized security strategies.

- **Education and awareness:**

The aim is to inform the public about the regulations and risks associated with the use of drones in restricted areas.

In summary, port security in Mexico addresses the drone threat through a multifaceted approach that includes regulation, technology, surveillance, and coordination among different institutions.

IV. Comparative Analysis.

This article compares the situation in Argentina, Brazil, and Mexico, identifying similarities, differences, and levels of progress in preventing the criminal use of drones in ports. The analysis considers three main variables:

1. Criminal Modalities.

Country	Most common forms of criminal use of drones.
Argentina	Prior reconnaissance, selective smuggling, coordination of illegal activities from the air.
Brasil	Rip-on / Rip-off of containers, direct transportation of drugs, interference with electronic surveillance.
Mexico	Cargo surveillance, personnel intimidation, drug transport, explosive attacks.

Common observation: In all three countries, drones are used for criminal intelligence, criminal logistics, and evading controls. Mexico has the highest level of sophistication and violence**.**

2. Marco Jurídico y Normativo.

Country	Level of Regulatory Development	Characteristics of the Legal and Regulatory Framework
Argentina	Intermediate	Decree 663/2024 regulates the general use of drones, with isolated institutional efforts by the Naval Prefecture.
Brasil	High	ANAC Regulation RBAC-E No. 94 and no-fly zones established by DECEA; a more robust institutional response.
Mexico	Half	Circular CO AV-23/10 R4 of the DGAC and recent reforms to the Penal Code; uneven implementation at the port level.

Regulatory Conclusion: Brazil leads in terms of regulation and operational capabilities, while Argentina and Mexico have made progress in reforms but have gaps in effective implementation.

3. Institutional Capacities.

Country	Level of Regulatory Development	Characteristics of the Legal and Regulatory Framework
Argentina	Limited	Reactive measures, without specialized technology; low investment in anti-drone capabilities.
Brasil	High	Specialized units of the Federal Police in key ports, with detection and neutralization systems.
Mexico	Average	SEMAR initiatives in priority ports; partial technological presence and disparity between ports.

Operational conclusion: Brazil has implemented the most advanced responses, with active technology and specialized teams. Argentina and Mexico still rely on fragmented or development-stage solutions.

4. General Comparative Synthesis.

Argentina	It advances in regulatory frameworks but faces serious technological and operational limitations.
Brasil	It shows the most complete model of regulation, prevention and technological response, although it still faces challenges in total coverage.
Mexico	It is the country most affected by the criminal use of drones, with violent scenarios and mixed response capabilities.

V. Adaptive Recommendations.

Technological innovation in maritime transport brings significant benefits, but also presents emerging risks to port security, including the illicit use of drones, which can affect the integrity of operations, the security of cargo, and the protection of people. Ports in the three countries sampled in this study face growing threats related to these devices, which can be used for espionage, smuggling, sabotage, or terrorist activities.

It is imperative to develop and implement a comprehensive strategy that addresses these threats from their various dimensions: regulatory, technological, operational, and social. The adoption of detection and neutralization technologies, along with greater inter-institutional coordination, specialized training, and awareness campaigns, will improve prevention and response capabilities against these emerging threats.

It is recommended to prioritize actions such as defining restricted areas, installing multimodal detection systems, training security personnel, establishing action protocols, and encouraging participation in international forums. Proactive and coordinated management will ensure the effective protection of port areas, promoting a safe and resilient environment.

As a result of this brief investigation, the following general considerations are put forward:

- International and regional cooperation is key to sharing information and strategies.
- Constantly updating regulations is essential given the rapid evolution of drone technology.
- The incorporation of specific anti-drone technologies and specialized training in port security should be a priority.

- There are various technologies to counter drones, from detection and tracking systems to mechanisms to neutralize or shoot them down. These technologies are classified as kinetic (which involve the physical destruction of the drone) and non-kinetic (which interfere with its control or navigation systems).

  Detection systems:

  - **Radar:** Uses radio waves to detect drones by measuring the way these waves bounce off the object. This allows the drone's presence, speed, and trajectory to be determined.
  - **Radio frequency (RF) scanners:** They detect the electromagnetic signals emitted by drones to communicate with their operator, identifying their presence and operating frequency.
  - **Cameras (optical and infrared):** They allow visual identification of the drone, with infrared cameras being effective in low-light or night conditions.
  - **Acoustic sensors (microphones):** Detect the sound of the drone to determine its location and trajectory.

  Neutralization systems:

  - **Electronic inhibitors:** They interrupt communication between the drone and its operator, forcing it to land or return to its point of origin.
  - **Signal Jamming:** Interferes with the drone's GPS navigation or communication signals.
  - **Protocol Jamming:** Modifies the drone's signals to take control of it or redirect it.
  - **Directed energy weapons**: These use microwave waves to disable the drone's electronic systems.
  - **Kinetic Cannons:** Fire projectiles to shoot down the drone.
  - **Capture systems:** They use nets or interceptor drones to catch the target drone.

  Other technologies:

  - **Artificial intelligence and machine learning:** These are used to analyze flight patterns and detect potential threats, as well as to improve the efficiency of anti-drone systems.
  - **Multi-layer systems:** These integrate different technologies to provide a more comprehensive defense against drones, combining detection, tracking, inhibition, and other actions.

- The choice of counter-drone technology will depend on the specific context, the potential threat, and available resources. Fixed, portable, and mobile systems offer different solutions for various scenarios.
- It is crucial to develop awareness campaigns to prevent the illicit use of drones and detect suspicious behavior early.
- Implementation of clear and strict regulations to establish laws governing the use of drones, including registration requirements, restricted zones, and penalties for illegal use.
- Development of detection and neutralization technologies to invest in anti-drone systems that can detect, track, and neutralize unauthorized drones in sensitive or restricted areas.
- Training and awareness-raising to educate authorities and security personnel in the use of anti-drone technologies and in protocols for responding to incidents.
- Inter-agency coordination to foster collaboration between different agencies, including police forces, military, critical infrastructure agencies, and civilian organizations.
- Real-time monitoring system to implement surveillance systems with cameras, sensors, and radars to continuously monitor vulnerable areas.
- Rapid response plan to create specific protocols to act quickly upon detection of an unauthorized drone, minimizing risks.
- Promote public awareness to inform the population about the risks and laws related to drones to reduce misuse.
- Continuous evaluation and updating to regularly review and update strategies and technologies to keep up with new threats and technological advances.

The security of the region's ports against the use of unauthorized drones, and by extension the proper functioning of logistics processes and international trade, would benefit from a regulatory framework and precise regulations on the subject. The regulations presented here, and others can serve as an example for those countries that do not have them or that have less developed specific regulatory frameworks and more lax approaches to aerial surveillance of their ports. This does not mean that general regulations on drones do not exist in those countries, but rather that there are no specific laws or regulations that address their use in the port context.

Drones are expected to continue to be used for criminal purposes, and advances in artificial intelligence are expected to further enhance their offensive capabilities. The proliferation of drones raises questions about international law and the need for rules governing their use in active threats in port airspace, considered critical and strategic areas. International cooperation and the adaptation of legal frameworks are crucial to address the challenges posed by the use of drones for criminal purposes.

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