Operational safety plan for the Amazon River Airport in Shell City, Pastaza Province, Ecuador

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Abstract

The objective of this study is to develop a safety plan for Shell-Pastaza Airport through compliance with and enforcement of international regulations. Information was collected through observation sheets, surveys and interviews at the airport facilities with the main actors of this air transport system. Satisfaction surveys were aimed at airport users. After the analysis of the primary information, it can be indicated that the airport has shortcomings in aspects such as: identification of danger zones, malfunction of strategic areas, absence of operational safety procedures in the presence of dangers. The construction and development of the operational safety plan is framed in the technical and administrative aspect of the airport, which must operate in a coordinated and harmonized manner. An operational safety plan will allow the airport to have protocols, procedures, dashboards and responsible in each of the eventualities that may arise.

Keywords: *Airport airport, safety, technical, administrative, hazard.*

1. INTRODUCTION

To carry out an operational safety plan, SMS (S afety Man a gement S ystem) is used, it is a system that serves to guarantee the safety of operations, through effective operational risk safety. The ICAO and its member states know that rules and regulations are not enough to prevent air accidents, the states are responsible for establishing surveillance systems at the national level, in such a way that there is a system that details operational safety in the

different areas: airlines, airports, maintenance workshops, air navigation systems, which is complemented by air regulations, legislation and regulations. [2]

Annex 19 of ICAO includes all concepts and standards relating to safety in civil aviation. This document is the main reference to establish an SMS and determine the acceptable levels of operational safety in a country or an airport. It is necessary to properly implement the guidelines established in the annex, its regulations and supplementary documents that will provide guidelines for all agencies and users of an airport to adequately perform their obligations as part of a system. [3]. A safety management model should include parameters necessary for the mitigation of acts that may cause accidents and affect aviation. [4]

Operational safety has evolved since the 50s, in which only human factors were considered as possible responsible for air accidents. For the 70s, human factors began to be considered and improvements in ergonomics and performance for pilots, cabin crew and other actors in the air transport system were considered. In the 90s, organizational factors were also considered as contributors to air accidents and incidents. To finally consider a total systematic analysis in which all the factors analyzed above have participation in a possible plane crash, and therefore the risks can be mitigated in each case. [5]

If the risks of Operational Safety are considered, it is important to consider the axioms of operational safety, which start from the idea that every system is vulnerable. Under this axiom, the differences between hazard, safety deficiencies, consequences and risks of operational safety are analyzed. The analysis and articulation of these principles make it possible to assess in a simple way the risk in terms of its probability and severity by assigning a number to the consequences of the hazards. This is an essential contribution to the safety management process by means of SMS because it provides the service provider with a basis for making strategic decisions on operational safety risks, to evaluate the allocation of resources or actions to dispose and minimize the effects of a hazard on the provision of services. [6]

A process manual can be developed for airport operational safety, creating a matrix of process indicators with standards and frequencies, this matrix being the one that will be monitored continuously through the main operational safety indicators, these indicators function in conjunction with those involved and the airport. In this way, it seeks to contribute to the improvement of the operational safety of the airport, preventing and avoiding accidents. [7]

It is necessary when the airport analysis is carried out to identify if there is full compliance with ICAO in what has to do with Annex 14 and 19, since through the investigation risk areas, avian precencies and fauna can be found in their surroundings; to avoid possible risks of accidents. Normally, periodic analyses of the total operation of the airport can be recommended after that and thus solve the problems that are identified. [8]. It is also necessary to carry out a situational study of the airport for the solvency of technical and administrative problems; This can be obtained by proposing a safety management manual, with the aim of preventing, identifying, mitigating risks. [9]

Another strategy proposed by several authors is the establishment of strategic processes for the identification, correction, measurement, of the occurrence of possible incidents and air accidents, this through the proposal of a strategic manual with corrective and preventive actions [10]. It can also include the exploitation of free zones and special regimes of the district at airports, where each function and process of operation, administrative and technical, is executed with quality, thus

reducing and avoiding possible accidents and incidents. [11]

The Safety Management System models can also be implemented in aeronautical training and training centers, increasing safety levels in these centers, since being students they can have failures and involuntary errors in their learning development, so it is necessary to have a safety system that prevents and avoids possible accidents. [12]

The development of occupational safety on the ground, of those who work in these areas (handling and maintenance), since their work is also essential for an aircraft to function optimally at the time of flight, in this way Effects of Air Transport

incidents and air accidents are prevented and avoided directly or indirectly. [13]. When analyzing the operational safety of an airport, it is necessary to execute an internal and external analysis that allows timely planning in this area of the airport, in order to avoid possible risks. [14]. It is essential to reduce existing risks against collaborators, physical infrastructure, users; Through continuous training and development of strategies not only technically but also these should be focused on the labor well-being of each worker, since the human factor is one of the main actors for the development of a correct and safe flight [15]

Table 1: Effects of Air Transport [16]

Direct Effect	Indirect Effect	Dependent Effect	Induced effect
Operators Airport Airlines and Air Navigation Services are located	There are suppliers, manufacturers and services.	Trade, tourism, employment, productivity, environment and investment.	It refers to the impact that is generated when suppliers, their employees and households return to spend in the economy, generating new economic activity.
IndustryThere are Engines, Aircraft, Equipment and Services.	Which is generated by the consumption of its employees		

Factors conditioning the air transport market

Political Factors: one of the main characteristics of the political factors was the liberation that the air transport industry had in the USA in 1978 through the revolution, this also influenced the privatization of public and mixed companies.

Economic Factors: oil is one of these factors globally and in each country, mentioning that in 2021 it had a cost of 61.90 USD per barrel and is currently at 14.57 USD, according to reports from Diario El Comercio.

Another economic factor to be highlighted was also the geographical distribution demanded in the United States of America for air transport; as an example, the most traveled route is cited, which is New York-London.

Environmental Factors: the main characteristics among others are: global warming, infrastructure development, legislation on the emission of environmental gases such as the "Kyoto Protocol" which seeks to reduce greenhouse gases. [17]

Operational safety

It seeks to proactively reduce risks in aviation, before they cause incidents or accidents. It is done through the activation of safety management, where nations can manage their

safety activities in a more comprehensive, disciplined and centralized way.

Understanding their role and contribution enables each country and the aviation industry to prioritize actions to address safety risks and manage resources more effectively for aviation safety.

In aviation, safety is dynamic; as new risks and hazards constantly arise that must be mitigated. The aviation system being very dynamic and open, as long as it is maintained at an adequate level of control, it can be kept safe. [18]

In Ecuador, the structure of operational safety is governed by the state, which is responsible for planning, regulating and controlling air navigation and airports within the territory. For the construction, operation and maintenance of heliports, airports and civil aerodromes and in the same way for the operation of their facilities and services, which includes that of air routes directly or by delegations, this according to the convenience of the nation; All this is developed according to provisions of the competent laws, aeronautical code, technical regulations, regulations, which must be in force based on the International Civil Aviation Organization (ICAO), being the Ecuadorian State a signatory of the same. [19]

To design an airport it is essential to review architectural projects of the same nature to observe the functional, technological characteristics that make an airport terminal or aerodrome work in an optimal way and be able to facilitate the process of departure and arrival of passengers or cargo in general, in addition to this it is also worth highlighting the typology of an airport to know if they could be applicable or be adapted according to the need of an airport. [20]

ICAO establishes the rules and regulations necessary for aviation safety, approval, effectiveness and global environmental protection. This report aims to provide members, the aviation community and the travelling public with high-level analysis of air transport safety trends and indicators. It is also a safety programme, highlighting the important leadership and innovation role of air transport on a global scale. [21]

In 2010 it was experienced that the total volume of scheduled commercial flights began to exceed 30 million per year. ICAO therefore seeks to continuously develop more dynamic, risk-based methods to further reduce global accident rates so that air travel can increase safely in all regions. The COVID-19 pandemic brought new challenges for global aviation. [22]

Figure 1. Evolution of global passenger traffic 1945-2020

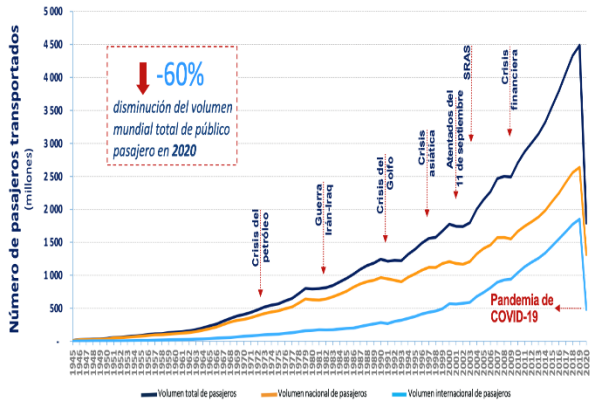


Figure 2. Air traffic by region

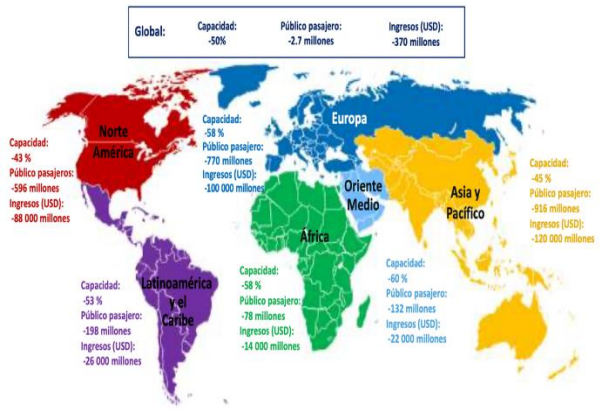


Table 2: Number of Accidents

Number of accidents: 2005 - 2010		
Year	**Number of accidents**	**Number of deaths**
2005	119	824
2006	112	806
2007	122	645
2008	136	524
2009	113	670
2010	127	707

ICAO works in partnership with the international aviation community to achieve a sustainable reduction in accident rates globally by focusing on improving safety performance in areas with high records.

The concept of safety is found in ICAO Annex 19 and in the third edition of ICAO document 9859 "Safety Management Manual ". Generally, it is a document that provides reinforcement on all aspects of operational security, focusing on its importance; operational safety is related to the entire life function cycle of an airport.

Safety risk

It is the probability and projected severity of a consequence or result of an existing situation or threat . The result may be an accident, an "unsafe intermediate consequence/event", which can be interpreted as a "most likely outcome" [23]

Probability of safety risk

The safety risk control process begins with the evaluation of the probability of occurrence of the consequences of risks during aviation activities carried out by the organization. [23]

Amazon River Airport

The Amazon River Airport is located in the Shell parish, Mera canton in the Pastaza Province of Ecuador. The airport was established in 1937 by Royal Dutch Shell, to provide an aeronautical service to the Amazon of Ecuador.

This airport is the main means of transport for the entry and exit of the indigenous population of Pastaza; a total of seven nationalities including the Achuar, Andoa, Shuar, Kichwa, Shiwiar, Waorani, Zápara and around 320 communities settle in the Ecuadorian Amazon and are the beneficiaries of the air terminal.

From this terminal, aircraft take off to authorized runways such as: Nuevo Curitza, Montalvo, Wiririma, Moretecocha, Pindoyacu, Jandiayacu, Makusar, Yusutnza, Lorocachi, Moretecocha, Llanchamacocha, among others. The trip can last between 30 minutes to 1 hour of flight depending on the remoteness of the runways and the climatic conditions of the region.

All operations at the Río Amazonas airport are carried out on HJ time, that is, from 06:00 to 18:00. During 2020, 11,627 air operations were carried out with a mobilization of 5,578 passengers and transportation of 12,823 kg of cargo.

Existing airport services at the airport

The airport has the following airport services:

- Airport infrastructure system

The airport has an operational control tower, equipped with technology and facilities that are required to provide quality service to internal and external users.

- Airport security and prevention systems

The airport has security equipment, the guard is responsible for safeguarding the security of the offices and facilities of the airport.

- Rescue and firefighting service.

If you have the rescue and firefighting service inside the airport.

- Fueling system (jetal – Avgas)

The airport does not have the refueling service.

2. Materials and Methods

First of all, the current situation of the Shell Río Amazonas airport must be determined, this was done through the application of an observation sheet in which information is collected on the infrastructure of the airport and the state of it. In the present investigation, the following aspects were analyzed:

Table 3. Aspects analysed in the observation sheet

Airport Overview	**IATA/ICAO code**	
	Location	
	Type of Administration	
	Operating hours	
	Types of transit permitted	
Track	Characteristics	Reference key
		Track length
		Track width
		Obstacle-free zone
		Fringe
		Margin
	Signals	Track threshold
		Track Designator
		Punto de visada
		Track axis
	Lights	Start of track
		Track edge and axis
		End of track
Taxiway	Characteristics	Taxiway length
		Taxiway width
		Fringe
		Margins
	Signals	Taxiway axis
		Waiting point
		Intermediate waiting point
	Lights	Taxiway axes
		Taxiway edge
		Stop bars
		Intermediate waiting point
Platform	Characteristics	Platform length
		Platform width
		Margin of separation
		Track turning platform
		Cargo terminal platform
		Number of parking spaces

		Service platform and hangars
	Signals	Safety lines
		Signs
		Parking stalls
	Lights	Platform lighting
		Guide lights
Passenger Terminal Building	Characteristics	Surface
		Type of infrastructure
		Administrative offices
		Dispatch of aviation companies
		Security check
		Waiting rooms
		Lighting
	Signals	Information
		Prohibitive
Control tower	Characteristics	Dimensions
		Height
		Type of infrastructure
		Control rooms
		Machinery and equipment
		Visibility
Electric power station	Characteristics	Electricity supply
		Secondary source
		Power quality
		Machinery and equipment
Weather station	Characteristics	Year of installation
		Equipment
		Meteorological Office
		Wind distribution quality
		Visibility
Airport Services	Characteristics	Ramp Services
		Cabin service
		Fuel supply
		Food supply
		Engineering Service
		Field Operations Services
		Loading and unloading
		Storage warehouses
		Baggage handling
		Machinery and equipment

		Customer Service
Integrated Aircraft Care System	Characteristics	Specialized Hangars
		Private flights
		Air traffic control
		Passenger attention
		Transportation services
		Free services
Rescue and firefighting service	Characteristics	Trained personnel
		SSEI Security Service
		Specialized machines and equipment
		Fire station
		Auxiliary water tanks
		Media/Alarms
Security service	Characteristics	Security check
		Accredited agent
		Safety Inspection
		Security zones
Environmental protection	Characteristics	Accredited agent
		Safety Inspection
		Sewage treatment plant
Radio aids	Radio aids en route	NDB (Beacon in directional)
		VOR (Very High Frequency Omnidirectional Radio Beacon)
		DME (Distance Measuring Equipment)
		Radio Beacon
		Communications
		ARSR (Air Route Surveillance Radar, Passive)
		ATCBRS (Airway Surveillance Radar, Active)
	Radio landing aids	ILS (Instrument Landing System)
		P.A.P.I. (Precision Approach Path Indicator)
		A.P.A.P.I. (Approximation indicator)
	Radio aids in the terminal area	ASR (Airport Surveillance Radar)
		ASDE (Airport Surface Detection Equipment)

Airport Overview

As indicated in ICAO Annex 19, there are different types of probability of a safety event occurring, the same as detailed in the following table:

Table 4. Probability of safety risk

Probability	Meaning	Value
Frequent	It is likely to happen many times (has happened frequently)	5
Occasional	It is likely to happen a few times (has happened infrequently)	4
Remote	It is unlikely to happen, but not impossible (it has rarely happened)	3
Improbable	It is very unlikely to happen (it is not known if it has occurred)	2
Highly unlikely	It is almost inconceivable that the event would occur.	1

Once the probability assessment is completed, the next step is to assess the severity of the safety risk, taking into account the potential consequences of the hazard. The severity of a safety hazard is considered to be the level of damage that can occur as a result of or consequence of a specific hazard. The following table presents the severity of the risk in operational safety:

Table 5. Severity of safety risk

Gravity	Meaning	Value
Catastrophic	• Destroyed equipment • Multiple deaths	**A**
Dangerous	• A severe reduction in operating safety margins, physical strain or workload, where operators are no longer reliable for the accurate or complete performance of their tasks. • Serious injuries • Major damage to equipment	**B**
Grave	• A significant decrease in the operating safety margin, a decrease in the capacity of operators, leads to unfavourable working conditions due to an increase in the workload due to conditions that affect their efficiency. • Serious accident • Injuries to people	**C**
Lightweight	• Discomfort • Operational constraints • Use of emergency procedures • Minor incident	**D**
Insignificant	• Few consequences	**And**

When assessing severity, all possible consequences related to the unstable nature or object should be taken into account, taking into account the worst-case scenario.

Table 6. Safety Risk Assessment Matrix

Probability of risk	**Risk severity**				
	Catastrophic **A**	Dangerous **B**	Important **C**	Levy **D**	**Insignificant and**
Common 5	**5A**	**5B**	**5C**	**5D**	**5E**
Occasional 4	**4A**	**4B**	**4C**	**4D**	**4E**
Remote 3	**3A**	**3B**	**3C**	**.3D**	**3E**
Improbable 2	**2A**	**2B**	**2C**	**2D**	**2E**
Highly unlikely 1	**1A**	**1B**	**1C**	**1D**	**1E**

To determine the levels of operational safety handled by an airport, the safety risk assessment matrix is considered, being expected that all risks are in the acceptable region and occasionally in the tolerable region. The intolerable region should be avoided, in all cases the measures recommended in the risk index table should be applied.

Table 7. Safety Risk Assessment Matrix

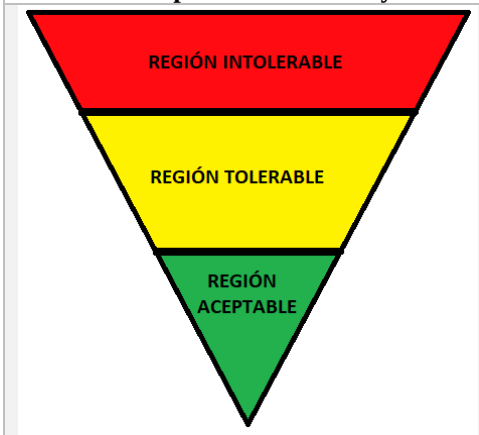
Description of tolerability	Risk index assessed	Suggested criteria
	5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under the circumstances.
	5D, 5E, 4C, 4D4E, 3B, 3C, 3D2A, 2B, 2C, 1A	Acceptable according to risk mitigation. You may need a management decision.
	3E, 2D, 2E, 1B,1C, 1D, 1E	Acceptable

Table 8. Risk index

Risk index range	Description	Recommended action
5A, 5B, 5C, 4A, 4B, 3A	High risk	If necessary, stop or reduce the operation. Prioritize risk mitigation so that there are additional or improved preventive controls to reduce the risk index to medium or low.
5D, 5E, 4C, 4D4E, 3B, 3C, 3D2A, 2B, 2C, 1A	Moderate risk	Plan a safety assessment to reduce the risk index to a low level if possible.
3E, 2D, 2E, 1B,1C, 1D, 1E	Low risk	Acceptable as is. No subsequent risk mitigation is needed.

Additionally, surveys were developed for the following interest groups operating at the airport, which were separated into two layers for the surveys: general population and airport administration and airlines.

General population: There were 5578 passengers transported to the year 2020, so on average monthly the airport has 430 passengers.

Shell Aviation Department: At the Rio Amazonas Airport there are 30 members of administrative staff and employees in general.

Airlines: Based on the investigation carried out, it was obtained that 5 airlines operate at the Amazon River airport: Alas de Socorro (SAMAFE), Aerokashurko, Aeroconexos, AeroFor, Aero Sarayaku including the Army Air Group No. 44 "Pastaza"

Aeroclubs: At the Amazon River Airport there are 3 training centers: Aerosertec, Coeavip, Aviaciones AV and Aero Police pilot school.

Table 9. General population stratum

Stratum	Frequency	Percentage
Average monthly users	430	100%

Table 10. Airport and airline management stratum

STRATUM	FREQUENCY	PERCENTAGE
Aviation Department Shell-mera	10	33,33 %

Staff for each airline	8	26,66%
Aeroclubs	12	40%
TOTAL	**30**	**100 %**

To determine the sample in the present work, the following formula was used with the following criteria.

$$n = \frac{N * \sigma^2 * Z^2}{e^2 * (N-1) + Z^2 * \sigma^2}$$

Where:

n: Sample Size

N: Population Size

Z: Confidence Level

P: Probability of success

q: Probability of failure

e: Precision (maximum permissible error in terms of proportion)

Sample according to stratum 1

Table 11. Sample according to stratum 1

Stratum 1	F	Sample
Users	430	203

Sample according to stratum 2

Table 12. Sample according to stratum 2

Stratum 2	F	Sample
Aviation Department Shell-mera	10	9
Staff for each airline	8	7
Aeroclubs	12	11
Total	**30**	**27**

3. Results and Discussion

A sample of 230 surveys was taken, obtaining the following results in terms of customer satisfaction:

Knowledge of the concept of operational safety

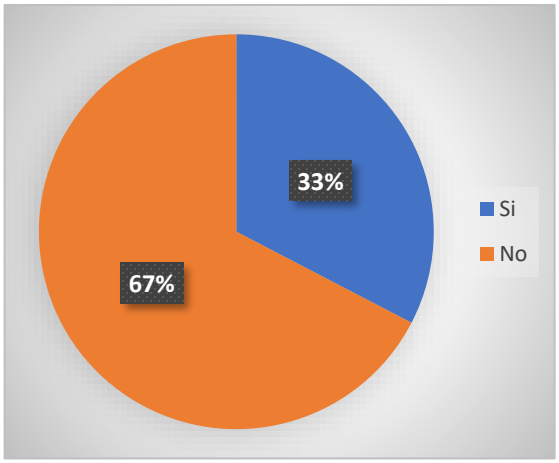


Figure 1. Safety concept

Aircraft have all the security measures

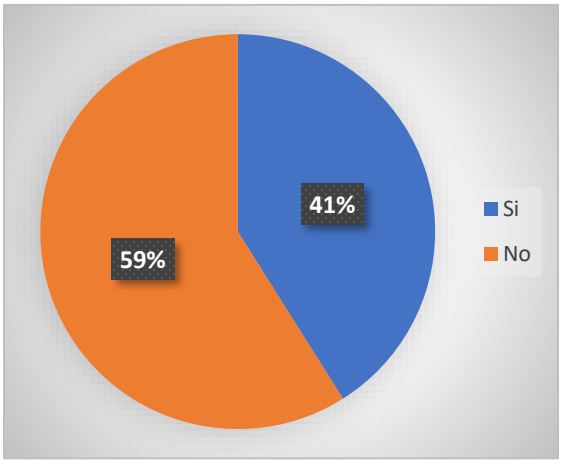


Figure 2. Aircraft security measures

The aircraft has adequate protective measures

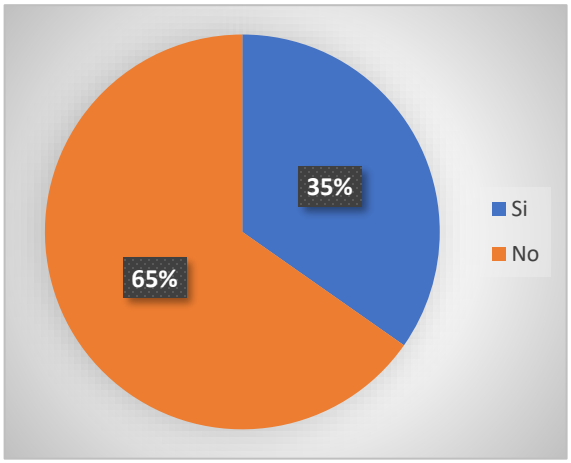


Figure 3. Protective measures on aircraft

Are you satisfied with the quality of service that Shell Airport has?

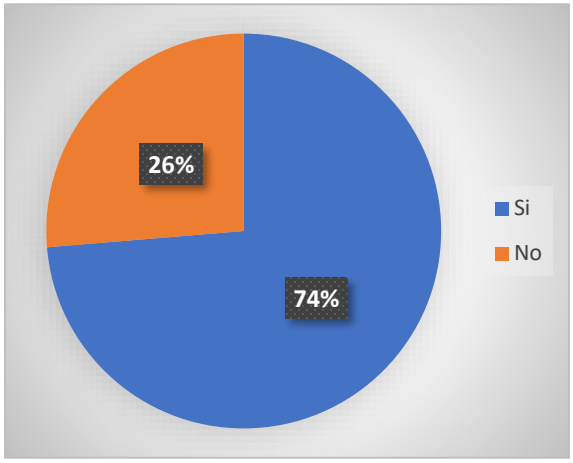


Figure 4. Quality of service at the airport

Does the staff of theeroline comply with the security measures?

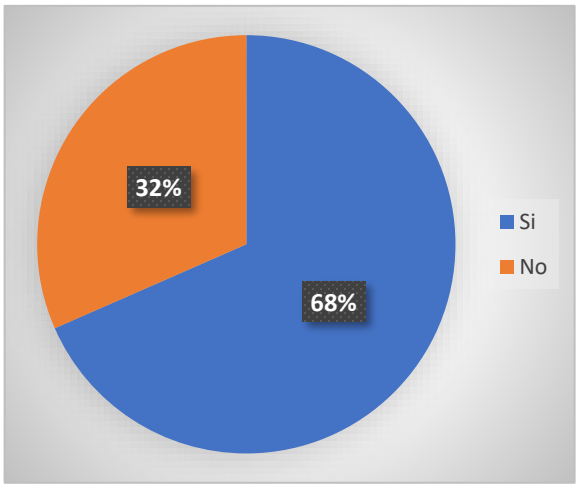


Figure 5. Airline Personal Safety Measures

Is it advisable to socialize safety issues to users?

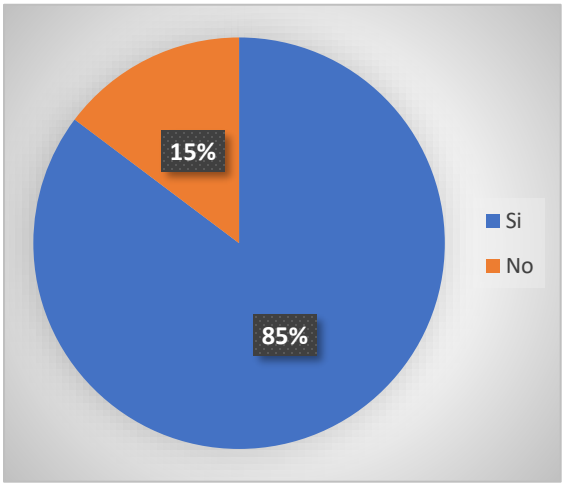


Figure 6. Operational safety for users

Are runway and aircraft conditions suitable?

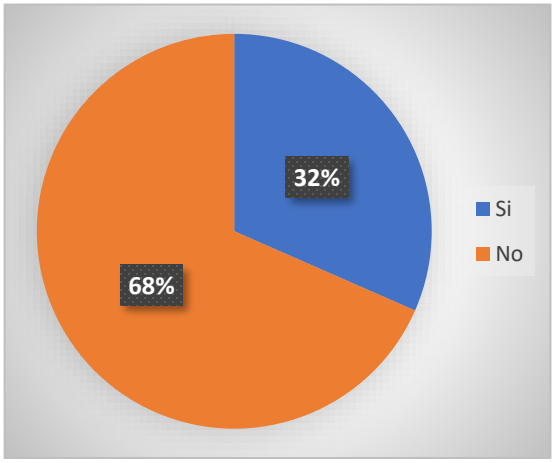


Figure 7. Runway and aircraft conditions

How often do aviation accidents occur at Shell Airport?

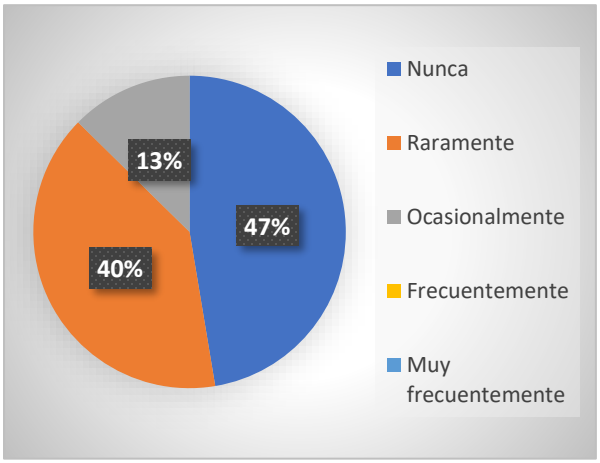


Figure 8. Frequency of accidents

How do you rate safety supervision and control?

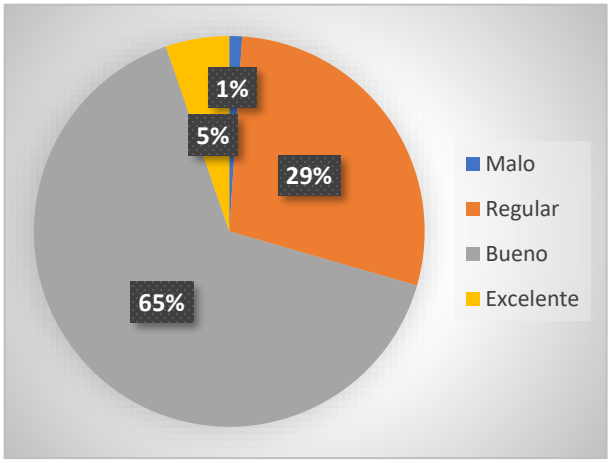


Figure 9. Safety supervision and control

Current situation of the Amazon River airport

To determine the current situation of the airport, an analysis was carried out with the background of the airport for the development of a proposal for an operational safety plan at the Río Amazonas airport, analyzing all the technical characteristics and infrastructural conditions, of each of the elements of the same, in order to comply with all the necessary parameters that an airport must have in accordance with the ICAO (Civil Aviation Organization). International, Annex 14).

Figure 12. Architectural plan of the airport

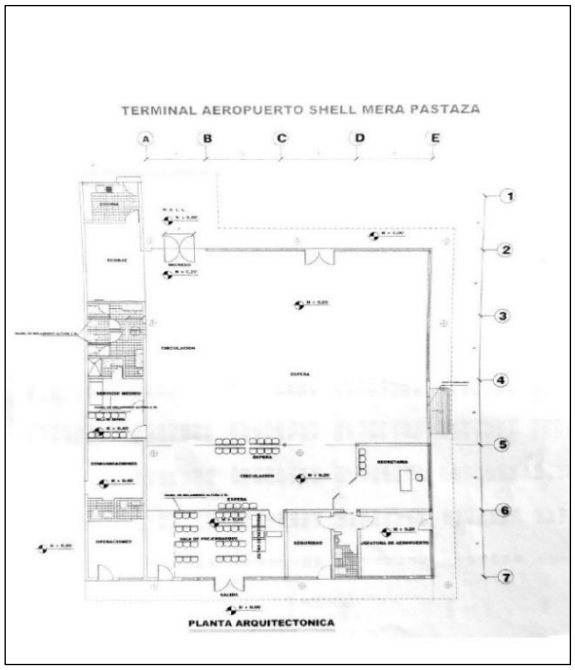


Table 13. Airport infrastructure

Airport infrastructure		
ICAO	**Amazon River Airport**	**Analysis**
Field of action surface which may be composed of grass pavement or compacted earth on which aircraft take off and land.	Field of action surface which may be composed of grass pavement or compacted earth on which aircraft take off and land.	The airport meets the standards regarding the floor of the surface of the runway highlighting that it is composed of pavement and currently grass and earth by construction materials.

Table 14. Length and width

Length and width		
ICAO	**Amazon River Airport**	**Analysis**
The length of the runway should be suitable to meet the operational requirements of aircraft, the width of a runway of a considered airport is 30m, it will correspond to a3rd **reference key.**	The length of the surface of the runway is 1 487 meters which satisfies the operational requirements of the aircraft, the width of the runway has a measure of 23 m which does not meet the letter of key specified by the regulations.	The currentlydeclared distances of the runway do not fully meet the needs of aircraft for operation and do not meet the requirements issued by current ICAO regulations.

Table 15. Fringe

Fringe		
ICAO	**Amazon River Airport**	**Analysis**
It is a defined surface which, includes the runway and the stopping area, in order to protect the safety of aircraft for visual flight runways must have a width on each side of 75 m with a length of 60 m.	The strip of the track has a length of 1607 m with a width of 80 m on each side, there is also a relatively natural environment i.e. weeds, grass and green areas.	The surface of the strip of the track has the measures established according to the regulations so it complies with the requirements. This is an aspect in favor of the safety of aircraft at the time of arrival or landing.

Table 16. Threshold signals

Threshold signals		
ICAO	**Amazon River Airport**	**Analysis**
A runway threshold sign shall consist of a configuration of longitudinal strips of uniform dimensions which shall be at least 30 metres long and 1,80 metres wide with a separation between them of 1,80 m.	Theairport does not have the function of threshold signs for an aircraft runway.	The surface of the runway does not comply with the markings or threshold signs as stipulated in the ICAO, which is necessary for good visibility to the pilot for landing or takeoff.

Table 17-3: Platform

Platform		
ICAO	**Amazon River Airport**	**Analysis**
Area intended to accommodate aircraft, with the objective of embarking or disembarking passengers, merchandise, fueling, parking or maintenance.	The airport has a large air parking platform that accommodates military flights in order to provide security to citizens.	The airport complies with the existence of a parking apron with large areas and adequate services.

Table 18. Control tower

Control tower		
ICAO	**Amazon River Airport**	**Analysis**
It must be high enough to have no blind spots and with good visibility, to control aircraft traffic, it is necessary to obtain a signal lamp, and various equipment that help the landing and operation of aircraft	The control tower is located 8m high, is in perfect condition and has all the necessary visibility of the movement area.	The control tower building has an efficient height and complies with the regulations since it allows visibility at the beginning of the runway and at the end thus obtaining better air traffic control

Table 19. Power station

Power station		
ICAO	**Amazon River Airport**	**Analysis**
The safety of operations at aerodromes depends on the quality of the electrical power supply, so a secondary source of electrical power is necessary in case the primary source of electrical power fails.	The electric power station is in adequate condition which is safe since it has a booth for the power plant at the airport also have a second sourceof energy supply in case the first one does not work.	The airport complies with a second electrical station which benefits the facilities and equipment in case of any failure of the first source, but these sources are in a suitable place and away from any accident or failure at the airport.

Table 20. Weather station

Weather station		
ICAO	**Amazon River Airport**	**Analysis**
It must be built 5 years before the construction of the airport as it provides information in all its atmospheric conditions; temperature, pressure, elevation, air humidity and winds.	The airport's weather station is located one level below the control tower and has the necessary equipment for the meteorological operation, which provides truthful data to inform about atmospheric conditions nationwide.	The airport complies with the existence and standards of the regulations with respect to the weather station itself that has high quality equipment and that allow accurate informationand allow toprovide a quality service to air operations.

Airport services

Table 21. General

General		
ICAO	**Amazon River Airport**	**Analysis**
They are services whose objective is to serve the aircraft from landing to its next departure, providing ramp service food supply, cabin services engineering service field operations service, loading and unloading.	The airport has the service of ramp, cabin and loading and unloading of goods.	According to current regulations, the airport does not comply with all airport services which help the aircraft for its air operations, so it is necessary to implement them as they benefit and offer security to passengers and aircraft.

Table 22. Storage and loading service

Storage and loading service		
ICAO	**Amazon River Airport**	**Analysis**
It allows to **offer** users a greater speed efficiency and flexibility, since it has facilities and complete services of handling unloading and packaging and with all the security measures	It does not have the machinery or equipment for handling loading and unloading the same ones that delay the mobilization and transfer of merchandise.	The airport does not comply with the specifications dictated by the ICAO, since they do not have the adequate facilities or necessary equipment either due to lack of management or by the administration.

Table 23. Integrated Aircraft Care System

Integrated Aircraft Care System		
ICAO	**Amazon River Airport**	**Analysis**
System that integrates both the attention of aircraft in specialized hangars, as well as the service of attention to passengers, providing them with all the quality services, includes in addition to the public transport service and also free services	There is no integrated system of passenger aircraft, public transport or free services that allow to provide quality services, the airport only has private flights for passengers.	The airport does not comply with an integrated system dictated by the ICAO which affects the development of the airport and interferes with the quality control of the service that must be provided to all citizens air operations center

Table 24. Rescue and firefighting services

Rescue and firefighting services		
ICAO	**AMAZON RIVER AIRPORT**	**ANALYSIS**
The existence of the firefighting service is mandatory at every aerodrome. The main objective of the service is to save lives in case of aviation accidents or incidents with the presence of fire.	The airport Rio A mazonas has the necessary facilities and equipment of aeronautical firefighters for the safety of the airport's air operations.	It complies with the regulations since there is its own fire department for the airport which is of vital importance its existence in case of a fire emergency in accidents or aerial incidents.

Table 25. Security services

Security services		
ICAO	**Amazon River Airport**	**Analysis**
The General Directorate of Aviation isthe authority responsible for civil aviation security matters in Ecuadorian territory to safeguard and protect aircraft, passengers and goods.	The Río Amazonas airport has services and equipment that safeguard airport security.	The airport has interests in terms of airport security; That is, it complies with the established security standards which helps to safeguard the security of the airport and passengers.

Table 26. Radio aids

Radio aids		
ICAO	**Amazon River Airport**	**Analysis**
Aids en route, NDB, emits non-directional electromagnetic waves. according to Annex 10, it emits that the frequency wave arranged for NDB, L is in the range of 190kHz-1700kHz	The airport has a very high frequency omnidirectional radio beacon and DME with frequency of r19 MHZ 12675 MHZ respectively operating 24 hours a day using a ground antenna.	The airport complies with the presence of two routeaids: VOR and DME. Cumple with the frequency established in the regulations since they are useful radio aids for the position of the aircraft.

Air scouts operating at the airport

Table 27. Air scouts

Aviation schools	PASTAZA-COEAVIPA Aviation School AEROSERTEK AVIACIONES OF
Private companies (social service)	Currently aviation companies are certified under RDAC-part 135 "scheduled and non-scheduled domestic flights"
Distress alerts - SAMAFE	Aerokashurko related air services "AEROCONEXO" Cia. Ltda. AeroFor
Military and police aviation	Due to the aeronautical facilities of the airport, the armed forces and national police determined that the military aviation that supplies its units located in the Ecuadorian Amazon Region, or gives aid to the population of the region, is based at this airport. Army aviation

Rio Amazonas Airport Traffic Mix

The most common types of aircraft operating at this airport due to the characteristics of the runway are:

Table 28. Types of aircraft operating at the airport

Aircraft type	Capacity (Passengers)
Arava Airplane	23
House 212	26
House 235	43
Hercules C130 aircraft	70
MI-8	24
Twin Otter	19
Bell 212 helicopter	09
Cessna 150	02
Cessna 182	04
Cessna 206	06
Piper Azteca	06
Super Puma	20
Cessna172	04
Gazella	05
Kodiak	09

The aircraft with the highest criticality in the event of an accident is the House 235 (CN 235).

Figure 13. Main actors of operational safety at the airport

Actors involved in an aircraft crash inside or outside the Rio Amazonas airport

Figure 14. Flowchart of actors involved in an aircraft crash

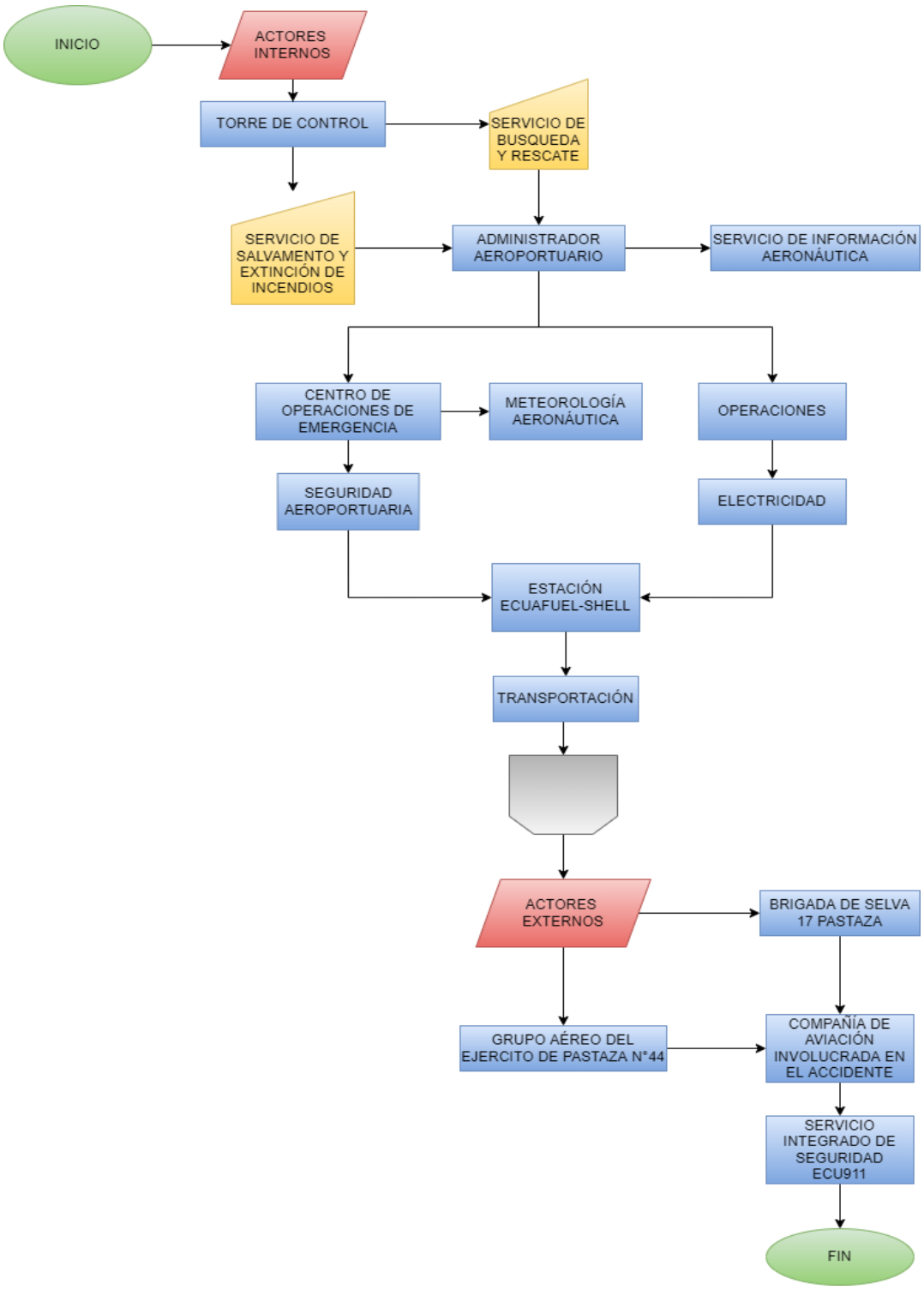
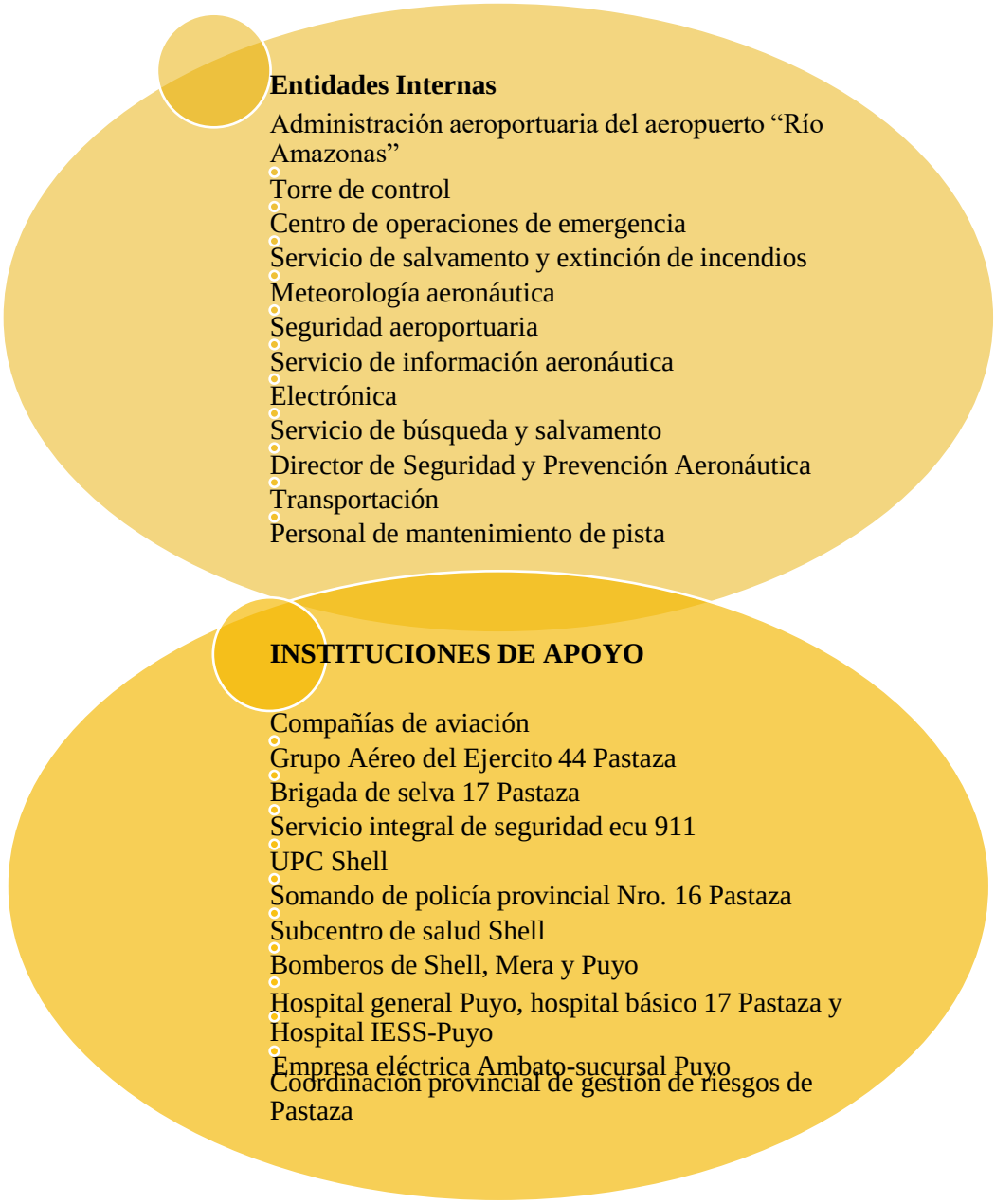


Figure 15. Internal entities and support institutions at the airport



Operational Safety Center

Annex 14 states that each airport must have an operations center which must be installed in a permanent and operational location with a mobile unit during the airport's business hours to support and coordinate operations in the event of an accident. Currently, the Emergency Operations Center (EOC) should be located at the Airport Authority. It also establishes the responsibility of the Ministry of Defense in the Aviation Safety Crisis Management Program to carry out all planned actions to respond to situations caused by illegal interference, as well as to combat the security crisis. aerial.

Assessment of operational security threat information

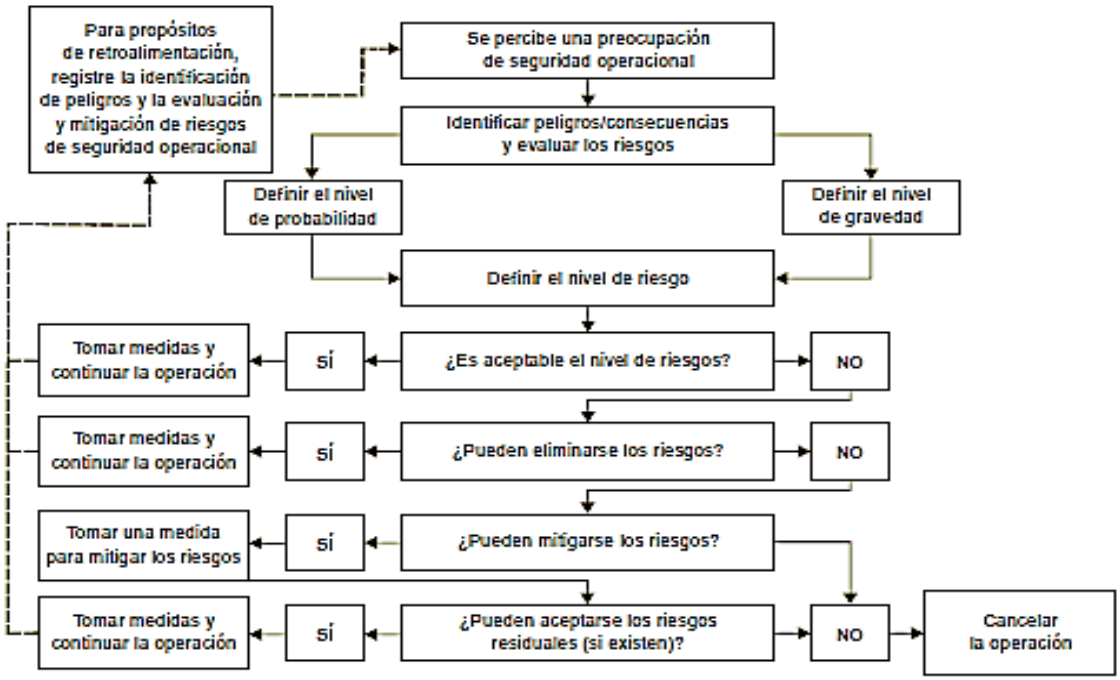
Civil aviation security authorities periodically assess the level and nature of the threat to civil aviation in the territory and airspace of the Republic of Ecuador, with information provided by the Secretariat of Intelligence and other relevant government agencies and based on civilian information , or Aviation security risk assessment tailored to the scope of the threat to civil aviation in the country.

Table 29. Levels of threats to aviation

Threat levels	
LOUD	It will be applied when an event generated by an act of unlawful interference or any attempt against the safety of operations and persons occurs, this level must be established when a critical condition is generated or when there is ordinary information that an aerodrome or airport operator or aircraft can be subject to some type of aggression.
MEDIA	It will apply when there are conditions that allow constant alert to be maintained about frequent circumstances regarding the operation of the aerodrome or airport or of an aircraft operator (strikes, theft, disruption of airport services, others)
CASUALTY	This level applies when it is considered that the development of public activity and the security measures taken, the aerodrome or airport or aircraft operator is not in danger of suffering any act that threatens its facilities or operations.

The process begins with the identification of risks and their possible consequences. Vulnerabilities are categorized by probability and severity to determine the level of risks. If they are considered tolerable upon evaluation, appropriate measures should be taken and operations can continue. Complete risk identification and safety risk assessment and risk mitigation are documented and validated and are part of the safety information management system.

Figure 16. Risk Mitigation Assessment



After assessing the risks, the service provider enters a decision-making process to determine whether risk mitigation measures should be implemented. To use the matrix described in

the methodology, risks can be categorized after assessing their severity and probability. Risks assessed as unacceptable (red and yellow categories) should be mitigated to reduce their severity and likelihood. The airport should consider suspending any activity that continues to expose the organisation to unacceptable safety risks if risk mitigation measures can be reduced to an acceptable level.

Table 30. Severity and probability of risk

		PROBABILITY				
		NOT LIKELY	SLIGHTLY LIKELY	UNLIKELY.	VERY PROPABLE	EXTREMELY LIKELY
SEVERITY	INSIGNIFICANT	LOW	LOW	LOW	MIDDLE	MIDDLE
	MINOR	LOW	LOW	MIDDLE	MIDDLE	MIDDLE
	MODERATE	MIDDLE	MIDDLE	MIDDLE	HIGH	HIGH
	CRITICAL	MIDDLE	MIDDLE	HIGH	HIGH	VERY HIGH
	CATASTROPHIC	MIDDLE	HIGH	HIGH	VERY HIGH	VERY HIGH

After assessing the operational safety risks at the Rio Amazonas airport, appropriate mitigation measures can be implemented. Mitigation measures can include several alternatives such as: training programs, modifications to existing operating procedures. Additional alternatives may include the introduction of new operating programs, training programs, technologies or surveillance controls. These alternatives will involve the development of traditional aviation safety defenses: technology, training and regulation.

The three safety risk mitigation approaches include:

a) Prevention. - the activity is suspended because the associated safety risks are intolerable or considered unacceptable.

b) Reduction. - Some exposure of operational safety risks is accepted, although the severity or probability associated with the risks is decreased.

c) Segregation of exposure. - measure to isolate the possible hazard-related consequence or to establish several layers of defences against it.

It is necessary to consider all possible measures to find the optimal form. Before making a decision, the effectiveness of each alternative strategy should be evaluated. Any proposed security risk mitigation alternative should be considered from the following perspectives:

a) Efficiency. The extent to which alternatives reduce or eliminate safety risks. Effectiveness can be determined in terms of technical, training and regulatory defences that can reduce or eliminate safety risks.

b) Cost/benefit. The extent to which the perceived benefits of mitigation outweigh the costs.

c) Practicality. The extent to which mitigation can be implemented and how adequate it is in terms of available technology, financial and administrative resources, legislation and regulations, political will, etc.

d) Acceptability. The extent to which the alternative is consistent with the administrator's paradigms.

e) Enforceability. The extent to which compliance with new rules, regulations or operating procedures can be monitored.

f) Durability. The extent to which mitigation will be sustainable and effective.

g) Residual operational safety risks. The degree of safety risks that remains secondary to the implementation of the initial mitigation and that may require additional risk control measures.

h) Accidental consequences. The introduction of new hazards and related safety risks that are associated with the implementation of any mitigation alternative.

Once mitigations are approved and implemented, any impact related to safety performance provides feedback to the service provider's safety assurance process. This is necessary to ensure the integrity, effectiveness and efficiency of the defence system in the new operating conditions.

Safety performance monitoring and measurement

The information used to measure the safety performance of the airport is generated through its safety notification systems, there are two types of notification systems:

a) Mandatory incident reporting systems: Rrequires certain types of incidents (e.g. critical incidents, runway violations), which require the implementation of detailed regulations defining the reporting criteria and scope of potential incidents notification capabilities, Mandatory reporting systems tend to collect more information on high-impact technical failures and other aspects of operational activities.

b) Voluntary incident notification systems: allow the sending of information about observed hazards or incidental errors, without the corresponding legal or administrative obligation to do so. In these systems, regulatory bodies or bodies may encourage reporting. Voluntary reporting systems can be confidential, requiring that any information that identifies the whistleblower be known only at the "point of entry." Youridentities are deleted after the necessary follow-up measures are taken. Unidentified reports can aid in analyzing future trends to monitor the effectiveness of security risk mitigation and identify emerging threats.

4. Conclusions

Based on the present study carried out, the standards required by the ICAO have been compared, the Río Amazonas airport based on the field work carried out has been able to detect some shortcomings within the airport, which does not comply with certain guidelines and specifications based on each item analyzed. an air transport system must be needs-based and based on the principles of quality and ICAO requirements.

It was diagnosed that the dangers and operational risks at the Río Amazonas airport are: problems in landing, lack of visibility, adverse weather conditions, lack of training and training, poor maintenance of the runway, however, these dangers and risks are little recurrent and can be reduced by applying adequate procedures and implementing the necessary resources of an airport to satisfy operational safety.

The risk indicators that allow detecting, obtaining necessary and required information to evaluate them in accordance with the operational safety plan and subsequently selecting the processes that must be assessed at the time of a degradation or failure in operational safety within the Río Amazonas airport were analyzed, which concludes that it, Due to its operability, it is constantly exempt from possible accidents and operational incidents.

Safety reporting tools should be easily accessible to operators. Operators should be aware of the benefits of a safety reporting system and get feedback on corrective actions taken in response to the report. Adapting the requirements, tools and analytical methods of the reporting system can facilitate the

exchange of safety information as well as the comparison of certain safety indicators.

To solve the shortcomings located, it was proposed the development of an operational safety plan, which contributes positively to the technical and administrative development of operational activities, which seek to reduce and optimize incidents caused at Shell airport, the planning developed will have a useful life of a period 2022-2026.

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