Zimbabwe's Preparedness in Aviation Disasters Management: A Case Study of Robert Gabriel Mugabe International Airport (RGMIA).

[1]Tafara Mlambo, [2]Davison Maunganidze

[1]MSc (Disaster Mgt), B.Comm (Mgt), Dip (Disaster Management)

[2]MBA, MSc, BSc (Psychology), Dip (HR), Dip (Bus Economics)

DOI: https://dx.doi.org/10.47772/IJRISS.2024.808075

Received: 25 June 2024; Revised: 24 July 2024; Accepted: 29 July 2024; Published: 31 August 2024

ABSTRACT

This research paper sought to determine Civil Aviation Authority of Zimbabwe's (CAAZ's) preparedness in managing aviation disasters paying particular focus on Robert Gabriel Mugabe International Airport (RGMIA). The study was largely prompted by the continuous failure by RGMIA management to conduct emergency exercises as a standard requirement by the International Civil Aviation Organisation (ICAO). The representative sample consisted of ten CAAZ management staff, five CAAZ flight safety standards inspectors, pilots, fire officers, two Civil Protection Unit directors and four Ministry of Transport Directors. The study employed qualitative research with a case study design. Data was collected through interviews. Qualitative data analysis was used in analysing data. The study established that RGMIA has satisfactory disaster preparedness plans but lacks financial capacity to carry out regular emergency exercises as required by ICAO. The research also found out that facilities and personnel at RGMIA cannot handle a large-scale aviation disaster. The study's recommendations are based on an exhaustive analysis of various aspects of the airport's disaster preparedness activities. RGMIA urgently needs to build capacity in terms of funding, equipment and training to keep abreast with international disaster preparedness best practices. CAAZ should also engage in Public and Private Partnerships (PPPs) in order to avert equipment and funding challenges that are affecting disaster preparedness.

Key Terms: Aviation, Disaster, Preparedness, Accident

INTRODUCTION

Aviation disasters are frequently reported in countries that have significant air traffic movements. Twigg (2004:12) defines disasters as serious disruptions of the functioning of a community or society, causing major human, material or environmental losses which exceed the ability of the affected society to cope using only its own resources. He states that disasters result from a combination of factors: the nature of the particular hazard or hazards; the extent to which people and their possessions are exposed to them; the vulnerability of those people and assets; and their capacity to reduce or cope with the potential harm. Many different kinds of hazards can contribute to disasters. These may be natural as in floods, earthquakes, landslides, and windstorms or technological/anthropogenic, for example, industrial and transportation accidents. In this particular research study, focus is on the preparedness to manage anthropogenic disasters.

Gero (1993) notes that commercial aviation came of age in the 1950s. The civil air travel boom began shortly after the Second World War, introducing to the average person that which previously had been available only to those wealthy and daring to board aircrafts. More flights were available to more destinations, with airlines carrying more passengers at greater speeds and higher levels of comfort and safety than ever before. It meant that more flights meant more accidents and by extension more aviation disaster losses in terms of human lives and property (Airbus, 2016).

At global level, there is no single day that passes without news about air crushes (Aviation Safety Network (ASN), 2018). It is these accidents which lead to aviation disasters. Numerous weekly if not daily incidents and

occurrences are reported at airports. An ASN, (2018) report shows that on 18 January 2018, a Convair CV-580F suffered an undercarriage collapse during a maintenance engine run-up test at Brownsville-South Padre Island International Airport, Texas, USA. The propellers contacted the ground, causing substantial damage. The right hand side of the fuselage showed a large tear.

According to Chaota (2017), Zimbabwe has not experienced major fatal aviation occurrences since Independence. However, a litany of accidents, incidents, occurrences, misses and near misses have been recorded. For instances, on 27 March 2017, a Britten-Norman BN-2A-3 Islander aircraft was damaged beyond repair after impacting Vumba Mountain near Mutare, Zimbabwe. All six occupants on board died on the spot (Danga, 2017). Information from the Civil Aviation Institute of Mozambique indicates that the aircraft hit the Vumba Mountain in Manica due to bad weather and subsequently crashed in the Mutare area. In a different report produced on the Aviation Safety Network site, on 23 October 2017, a Zimbabwe National Parks Authority operated helicopter crashed under unknown circumstances in the Hwange National Parks area. However, occupants, a pilot and a passenger were not injured (ASN 2018). It is against this background that the researchers were motivated to carry out this study investigating on Zimbabwe's preparedness in managing aviation disasters with particular focus on Robert Gabriel Mugabe International Airport (RGMIA).

Problem Statement.

Zimbabwe has not witnessed a major tragic aviation disaster in its airspace which has resulted in loss of human lives and damage to infrastructure. However, she continues to experience mishaps, incidences, misses and near misses every now and again. In spite of those minor incidents the anecdotal evidence indicates that CAAZ has failed to carry out International Civil Aviation Organisation (ICAO) obligatory emergency management exercises that are meant to test preparedness, casting doubt among researchers, aviation stakeholders and its customers on the authority's preparedness to handle major aviation disasters in the event they occur at the Robert Gabriel Mugabe International Airport (RGMIA). In particular, CAAZ has failed to carry out full emergency exercises since 2015, creating a conducive environment for an aviation disaster. This is on the background of increased expansion of aviation institutions and the global interest to the Zimbabwean airspace. Given this background, this study attempts to explore the preparedness of CAAZ in handling aircraft disasters focusing on the RGMIA.

Research Objectives

1. To analyse CAAZ's preparedness in managing aviation disasters at RGMIA
2. To examine CAAZ's level of compliance with available aviation policies on aviation disaster management
3. To identify aviation disaster management skills that are possessed by CAAZ staff
4. To establish the challenges being faced by CAAZ in implementing aviation disaster preparedness measures
5. To make recommendations on how CAAZ can improve on disaster preparedness and management

METHODOLOGY

The study employed a qualitative technique. However, the case study design largely underpinned the study. In this case the single unit of study was an institution, Civil Aviation Authority of Zimbabwe which superintends Robert Gabriel Mugabe International airport. As stated by Merriam and Simpson (1984), a case study tends to be concerned with investigating many, if not all, variables in a single unit. In this case study of Robert Gabriel Mugabe International Airport, both management and non-management staff were part of the population. A sample of 20 of the two integration units of management and non-management staff was purposively selected for the study because it exhibited characteristics of interest to the researcher. Interviews were the data gathering tools used. A pilot study using was carried out at the airport. The five respondent members of staff who

participated in the pilot study were selected by convenience and were not included in the main research. The researchers also pilot-tested the interview research questions scheduled for both categories of staff.

THEORETICAL FRAMEWORK

In this research paper, two academic theories, High Reliability Organisation Theory (HROT) and the Normal Accident Theory (NAT) were used. These theories are relevant in explaining the role of aviation organisations in minimising man-made disasters in the technological realm. Organisational factors play a role in almost all accidents and are a critical part of understanding and preventing them. Two prominent sociological schools of thought have addressed the organizational aspects of safety: High Reliability Organizations (HRO) (LaPorte 1996; LaPorte and Consolini 1991; Roberts 1990a; 1990b; Rochlin 1987; Weick 1987; Weick and Roberts 1993; Weick et al. 1999) and Normal Accident Theory (NAT) (Perrow 1999; Sagan 1995).

Major Hazard Installations refer to technologies that provide highly needed industrial, agricultural and transportation services, with typical examples being nuclear power plants, airports, aircrafts and air traffic control as well as petrochemical plants. Ironically, the same technologies that are celebrated for enabling growth and promise global prosperity may also cause major disruptions and undesirable long-term consequences. RGMIA is one such Major Hazard Installation because of its huge infrastructure and the fact that aircrafts land and take off from the airport. In this study, the airport's vulnerabilities to disaster risks were the major drivers that the research was conducted to try and address gaps in disaster management by CAAZ. Segan, (1995) postulate that Major Hazard Installations are risky technologies that cause major disruptions and long-term consequences.

The High Reliability Organisation Theory (HROT)

The HROT was propounded by La Porte, Rochlin, Roberts, Weick and Consolin (1994) after observing that organisations have a role to play if any form of disaster is to be minimised. The theory asserts that organisations should be able to manage and sustain almost error free performances despite operating in hazardous conditions where the consequences of errors can be catastrophic (Lekka, 2011). The model is based on effective management of risky technologies through effective organisational control of hazards and probability of occurrence of these hazards. The theory also applies to CAAZ as an organisation that administers Major Hazard Installations in the country. However, the civil aviation management body is not prioritising issues of disaster management despite past occurrences of incidents and accidents around the country that has the potential to degenerate into major disasters. As suggested by La Porte *et al*, (1994), the High Reliability Organisation Theory is a critical perspective to consider when explaining the causes of technological disasters and their possible solutions. In this respect, CAAZ is also targeted by the theory as the administrator of disaster risk reduction in the aviation sector.

Weick (1999) offers five characteristics of a High Reliability Organisation. These are preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to experience. In short, the HRO researchers averred that organisations can become highly reliable and avoid system accidents by creating the appropriate behaviours and attitudes (Weick and Roberts, 1993). In that respect, aviation disaster management is a prerequisite in the airline industry. According to this theory, efforts to reduce aviation disasters are in tandem with aviation safety programs and campaigns offered by international aviation organisations such as ICAO and IATA through CAAZ. Adherence to internationally recognized safety standards is a pre-occupation of the major concerns of civil aviation organisations. According to Mupfururirwa cited in the (CAAZ Aviation Magazine Vol 4, 2018), in 2016 Africa recorded zero passenger fatalities and zero jet hull losses mainly due to increased awareness to safety responsibilities by all aviation stakeholders and a collaborative approach to compliance with safety and security regulations. Governments have also played a central role by showing increased commitment and support for compliance to international standards for safety and security. Against this background, the applicability of the HROT to explain the results attributed by Mupfururirwa (2018) is a possibility. However, although Africa recorded zero fatalities, the application of HRO techniques to avert air disasters should be continued by organisations in the aviation industry. Bureaucratic rules which are sometimes blamed for stifling expert knowledge are applied in the HROT to serve as guidelines on the operations of organisations (Roberts, 1993).

Normal Accident Theory (NAT)

NAT was developed as an alternative to the explanation of technological disasters and proposed solutions. Perrow (1994) argues that there is a particular class of accidents that are normal, inevitable, and are often potentially disastrous. These occur in systems with many components, complex interconnections, and strict dependencies on stringent performance conditions. The complex and interconnectedness nature of aircrafts and the various aviation paraphernalia at RGMIA requires that CAAZ have adequate knowledge and skills to prepare for aviation disasters that according to Perrow, (1994) are inevitable. In systems like this, it is computationally impossible to anticipate all of the failures that might happen. One also cannot tell how failures might compound each other if two or more were to happen simultaneously (Perrow 1994). Relatedly, on the aspect of preparedness, technical measures are also key in averting air disasters. As such, any technical deficiencies without the input of human error can lead to aviation tragedies.

Between design limitations (which normally occur during aircraft manufacturing phase), equipment failures (aircraft technical faults during operations), procedural errors (aeronautical communication and Air traffic control (ATC) procedures), operator error (human errors from pilots and ATC), problems in supplies and materials (due to non-availability of spare parts), and unknown variables in the environment such as weather, Perrow, (1994) calls this set of considerations DEPOSE. There will always be unforeseen complications and unexpected contingencies. Related to these observations, air disasters in respect of aircraft design limitations have been cited in the Russian made Illusion type of aircrafts with a number of reported accidents in 2014 being linked to design errors. When multiple factors combined to produce accidents in such systems, it was rarely impossible to figure out what was going on in real time.

LITERATURE REVIEW

Contributing Factors to Aircraft Accidents

Devine (2009) categorises causes of aircraft accidents into those associated with structural defects, human error, terror attacks, and bad weather among other causes. These shall be discussed hereafter.

1) Human Error

Accident investigators attribute most aviation crashes to human error, predominantly pilot error and less often maintenance error and occasionally controller error (Krey 2007). Among commercial jet airplane operations worldwide, 66% of full-loss accidents were attributed to flight crew in the period between 1992 and 2001 (Boeing, 2006). In general aviation, which combines personal flying and corporate flight operations, the rate, is even higher. Around 79% of U.S. fatal accidents in 2006 in these operations were attributed to pilot error (Krey, 2007).

There is a growing consensus in recent years that human factor errors made by experts, such as professional pilots, controllers, dispatchers, and mechanics are not root causes but symptoms of flaws and inherent limitations of the overall socio-technical systems in which these experts work and the innate tension and trade-offs between safety and production in any system (Bogner, 1994; Perrow, 1999; Rasmussen, 1990; Reason, 1990, 1997; Woods, Johannesen, Cook, and Sarter, 1994). Further, the skilled performance of experts and the errors that they make are so closely interrelated as to be opposite sides of the same coin.

The way these multiple factors operate and interact is illustrated by a handful of accidents over the years in which airliners approaching an airport in the vicinity of thunderstorms encountered wind shear and crashed (Dismukes et al 2007). Flying around thunderstorms during approach is common practice, and the vast majority of the time the pilots are able to land safely at the destination airport, though sometimes it is necessary to go into holding or divert to another airport. On those rare occasions when an airliner encounters wind shear from which it cannot escape, typically the flight crew is faulted by accident investigators for poor judgment. Mashabhabhe (2010), as cited in a CAAZ accident report mentioned a case of an Air Zimbabwe Pilot on a flight from the Democratic Republic of Congo (DRC) to Harare who in 2008 disregarded advice from air traffic controllers to avoid two converging storms. The result was that the aircraft sustained damages to the left wing, although it

landed safely at Harare.

Pilots are particularly susceptible to perceptual errors when their sensory input is degraded as is the case at night or in visually impoverished environments. Aircrew run the risk of misjudging distances, altitude and descent rates, as well as responding incorrectly to a variety of visual illusions. There are times when human errors, particularly by pilots and air traffic controllers, have led aircraft to miss runways, crashing into stationary objects like buildings and other planes. This has often resulted in fire outbreaks. According to Nichols (2003), cited in a United States of America National Transport Safety Board report, out of the forty aircraft accidents at or near Hayward Airport since 1983, seventeen were the result of human error.

Air traffic controllers have the large responsibility of making sure that the various planes and pilots are not going to endanger each other. Pilots are dependent on them to give timely, accurate information about everything from weather to landing patterns and runway positions. Collisions can occur if this information is not accurate and prompt (Kumar and Malik, 2003). Recent reports of air traffic controllers acting dangerously only bring more attention to the potential consequences of their actions. In 2005 it was reported that by August, 200 human-related errors had been made by New York air traffic controllers, compared to 24 for all of 2004. Just like pilots air traffic controllers have responsibilities of which mistakes and lapses in vigilance can result in aviation accidents and losses of life (Krasner, 2009).

2) Non-Compliance to Set Regulations

The aviation industry is a sensitive domain which demands maximum adherence to set standards and regulations to avoid unnecessary accidents. As such, the International Civil Aviation Organisation (ICAO) and member states including Zimbabwe under (CAAZ) has specific rules that cover all parts of air travel that includes the equipment, ground personnel, passengers, luggage security, pilots and airports. These rules are designed for the safety of everyone involved and breaking them creates extremely dangerous situations (ICAO, 2004). ICAO (2009) regulations provide that aviation authorities must carry out full emergency exercises and tabletop within their respective airports at regular intervals. This forms part of practical training in preparation of aviation disasters. However, failure by civil aviation authorities to comply with such regulations can lead to poor responses in the event of a disaster, hence this study to explore the preparedness of CAAZ to manage aviation disaster.

However, non-compliance with regulations is a result of a multiplicity of factors including political bureaucracies, autocratic leadership which take a toll on airline personnel, inadequate financial resources to guarantee compliance and policy inconsistencies which affect the easy of doing business among others (Turner, 2016). Air Zimbabwe has been a victim of the mentioned challenges, exposing it to numerous business vulnerabilities through non-compliance. According to Chaota cited in a Parliament Portfolio Committee on Transport and Communication report (20017), management at Air Zimbabwe were on several occasions advised by the portfolio committee to ground the entire fleet owing to reports of non-compliance with domestic, regional and international standards. This resulted in Air Zimbabwe aircrafts were on a number of occasions detained in Europe and South Africa on several occasions for failure to comply with set safety standards.

3) **Structural Defects of Aircrafts**

Aircrafts experience defects during manufacturing with some developing during their useful time. However, due to corporate policies, such issues are not revealed for fear of loss of business than human life. Devine, (2009) advances that structural defects can lead to dramatic and unpredictable aviation accidents. Aircraft defects range from faulty or aging wires to corrosion and fuselage loss. In 1988, a Boeing 737 flown by Aloha Airlines experienced a ruptured fuselage, tearing part of the cabin apart and blowing a flight attendant off the plane to death. The accident was caused by problems with the adhesive bonding process, a problem Boeing was already aware of (Devine, 2009).

Structural problems in an aircraft are usually related to corrosion, surface cracks, fatigue cracks and skin disbands (Devine, 2009). Aging aircrafts may experience structural defects from general use and lack of maintenance. An important potential source of common modern failure in a wide range of high integrity equipment such as an

aircraft is damage to power and control lines. This is a particular problem in aircraft due to their attenuated shape and the lack of space usually available.

The ICAO has strict guidelines in place governing how often these checks have to be made. Engine failures have caused a number of accidents and Nichols (2003) cited in a United States of America National Transport Safety Board (NTSB) recorded that out of the forty air accidents at or near Hayward Airport since 1983, twelve were a result of internal aircraft problems including engine failure and fuel leak. Other internal problems include power and gear failure, which have led to crash landings, resulting in loss of life and property. Engine failure is a mechanical problem that can easily lead to aviation accidents. There are many reasons why engine fails. Among these are insufficient fuel supply and the breaking of engine parts (Devine 2009). For that reason, pilots and crew are required to undergo specially trained to manage engine failure as best they can by gliding the plane to a safe landing. Sadly, aviation accidents resulting from aircraft mechanical problem can be horrific (Devine, 2009).

When these problems go undetected, the lives of passengers and flight crew are endangered.

4) **Weather Conditions**

Aircrafts operate in all types of weather conditions and high altitudes they fly in. According to Ashley (2006), it is said the higher one goes the cooler it becomes, a condition that is unavoidable with all aircrafts during their flying life span. Adding to this, aircrafts fly in tropical, temperate, equatorial regions, rainy and windy conditions. These, though, not clearly noticed by a necked eye, subject aircrafts to severe exigencies which can lead to disasters. According to Humphrey (1930), weather and aviation have a complex relationship that has plagued aviation for more than a century. Operating an aircraft safely within the atmosphere means that a pilot should have at least a basic knowledge of weather processes and how to recognize certain weather hazards.

The idea that pilots should have a fundamental understanding of weather is not new. Humphreys **(**1930**)** noted that when the aviation industry became more influential for both mail and passenger transport in the early twentieth century, pilots should have at least some understanding of weather processes, the possible hazards associated with weather, and how to recognize those hazards while en route. Specific weather hazards commonly noted by Henry (1930) were ‘fog’ and ‘sleet’, where ‘fog’ referred to any time a pilot operated in clouds and ’sleet’ referred to ice formation on the airframe.

The Disaster Management

Disaster management is a cyclical process; the end of one phase marks the beginning of another (see Figure 1). Timely decision-making during each phase results in greater preparedness, better warnings, reduced vulnerability and or the prevention of future disasters (Quarantelli, 2005). Cognisant of this, CAAZ strives to manage aviation disasters using modern technology and the application of policies and regulations governing aviation disaster management.

Figure 1: Disaster management cycle (Source: Quarantelli 2005)

Mitigation refers to any action taken to minimise the extent of a disaster or potential disaster. Mitigation can take place before, during or after a disaster, but the term is most often used to refer to actions against potential (Twigg, 2004). The response or relief phase refers to the time period for humanitarian assistance, when steps are taken to save lives and to provide essential supplies to those most affected. It includes such activities as search, rescue, evacuation, provision of shelters, first aid, emergency medical care and protection, and early actions to register victims (Quarantelli, 2005). The rehabilitation or transition stage includes activities required to return normalcy to the affected areas and communities. Problems related to the emotional and psychological recovery of the victims including inhabitants of the disaster area are addressed during this stage (Quarantelli, 2005). Finally, the reconstruction stage includes activities designed to rearrange the affected physical space and environment and enable the allocation of resources in accordance with the new social priorities arising from the effects of the disaster (Quarantelli, 2005).

Managing Aircraft Disasters

The aviation industry has always quoted safety at the forefront of its priorities. As a general rule CAAZ should incessantly learn from past and present aviation disaster situations so as to factor in changes that lead to improved safety. This somewhat proactive approach should help in reducing the probability of accidents preferably to low levels witnessed in the mid-1980s where the fatal accident rate in air transport operations were fairly stable, despite a growth in traffic during the same period (Ayres 2009). This trend should be maintained by CAAZ as Zimbabwe seeks to become a regional hub in air transport operations. CAAZ should remain awake to the fact that as traffic grows, the total number of aviation accidents and attendant disasters also grow exponentially (Ayres, 2009).

The ICAO, recognizing these facts and that "the public's perception of aviation safety is largely based on the number of aircraft accidents rather than the accident rate", issued a resolution to "reduce the numbers of accidents and fatalities irrespective of the volumes of air traffic" (ICAO, 2004). The ICAO further provides guidelines on how to achieve this resolution, including the recommendation to "develop a civil aviation safety management framework and recommendations for improving safety" (ICAO, 2004). CAAZ has done well to adhere to the ICAO safety a factor that explains the few air traffic incidents it experiences.

In recent years a great deal of effort has been devoted to explain and understand how aviation accidents happen. It is generally accepted that most accidents result from human error. It would be easy to conclude that these human errors indicate carelessness or lack of skills on the job, but such a statement is not academically conclusive, hence this study to provide academic answers to the hypothesis. Aviation accident investigators have found out that human error is only the last link in a chain that leads to an accident (Boeing, 2006). Accidents cannot be prevented by changing people; they can be prevented only when we address the underlying causal factors (Ayres, 2009).

There are two ways to deal with aviation safety. The traditional way is that aviation safety has been about avoiding costs. In this sense, many aviation organizations have been bankrupted by the cost of a single major accident (Ayres, 2009), a condition which makes a strong case for aviation safety. The cost of occurrences is only part of the story. Efficiency is the second way of thinking about aviation safety. According to Ayres (2009) aviation safety and efficiency are positively linked. Safety pays off in reduced human and equipment losses in the aviation industry. There are also benefits in enhanced productivity and lowering of insurance costs.

The aviation industry should use proactive approaches to mitigate the effects of disasters. The higher percentage of CAAZ's duties should therefore involve preventing disasters rather than just investigating the causes. The work of CAAZ is derived from ICAO which sets internationally acclaimed standards in civil aviation operations. As such, systems should be in place at CAAZ to prevent, investigate and to recover from such disasters should they occur. According to Mupfururirwa (2018), cited in a CAAZ Aviation Magazine Vol 4, 2018, after the Mutare air crash which claimed five lives, CAAZ instituted an official inquiry to determine the circumstances leading to the disaster.

History of Aviation Industry and Safety Processes.

The history of aviation safety processes dates back to 1944 when states came together and agreed on principles

and arrangements to ensure the safety and standardisation of civil aviation operations (Airbus, 2017). During that meeting, stakeholders from various countries signed a document commonly referred to as the Chicago Convention. This document contains 96 articles which govern civil aviation operations today.

Articles 17-21 deal with the conditions for registration of aircrafts while Article 31 specifies the requirement to hold a Certificate of Airworthiness for all aircrafts involved in international flights (Airbus, 2017). Article 37 requires all contracting states to establish a means by which the Chicago Convention provisions are upheld and that the uniformity with the rest of the world is maintained. Other articles relate to the assistance of aircraft in distress, investigating accidents and amenities that each state should provide, be it at its airports or within its airspace to reduce the possibility and or effects of accidents should they occur (Airbus, 2017). All the contracting states, including Zimbabwe, who are signatories to the convention, are bound by these articles. CAAZ draws its safety policies and procedures from the 1944 document.

Another important instrument in the aviation industry is the Technical Guidance Material which is a set of documents that provides a step by step process of achieving aviation safety through airworthiness of aircrafts. The following are some of the Technical Guidance manuals.

1. **ICAO Doc 9734 - Safety Oversight Manual:** This document describes the structures that should exist within a state civil aviation authority. It explains the general setup, the qualifications of the staff, the required training and how their duties are supposed to be conducted. By so doing, the same standard is maintained worldwide and ensures aviation safety.

2. **ICAO Doc 9760 - Airworthiness Manual:** It describes the airworthiness procedures. Examples of processes contained therein include how a Certificate of Airworthiness is issued for the first time after an aircraft is imported into Zimbabwe, how it is renewed, considerations for registration and even approval of various airworthiness documents.

3. **ICAO Doc 8335 - Inspection and Surveillance:** One of the main duties of a civil aviation authority is inspection of aircrafts. This document standardises the inspection function by providing inspection procedures, intervals and checklists used during inspections. Initial inspection is followed by surveillance, which is a process to ensure that the same conditions upon which an approval was granted remain in existence. The manual provides guidance on surveillance activities. If all the processes and recommendations in the guidance material are followed, the possibility of aircraft accidents is greatly reduced.

In compliance with these guidelines, the Zimbabwean government through CAAZ has not fully maintained its visibility to ensure that accidents are avoided by adhering to the provided international best practices contained in the Technical Guidance Material. Avoidance of aviation accidents means that aviation disaster can be minimised (Ayres, 2009).

Compliance to International and Regional Aviation Disaster Management Policies.

The Civil Aviation Authority of Zimbabwe is a signatory to international aviation disaster management policies, themselves, derivatives of ICAO standards and is domesticated for easier implementation. These policies cover aeronautical communication, air traffic control, aircraft accident and investigations, search and rescue and aircraft airworthiness. A UNDP (2011) report shows that CAAZ has been complying with ICAO policies by way of segmenting these critical requirements into departments whose duties and responsibilities are related to disaster management among others. These have had a positive impact on CAAZ safety oversight and other aviation disaster preparedness operations since their establishment. Additionally, article 37 of ICAO provides that each contracting State undertakes to collaborate in securing the highest practicable degree of uniformity in regulations, standards, procedures and organization in relation to aircraft, personnel, airports, airways, and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation. In that respect, CAAZ is a member of the SADC regional safety oversight council which covers South Africa, Botswana, Zambia, and Mozambique in the area of air traffic management. The coordination is done through a satellite based direct speech circuit (VSAT). The goal is to create a regional harmonised air navigation system

(Chaota, 2018).

The trend of regionalisation in oversight of air transport, manifested through the formation of Regional Aviation Safety Organisations (RASOs), is designed to assist states in meeting these obligations through the pooling of resources, the delegation of oversight functions, and the harmonisation of regulations. Nevertheless, the concept of providing regional oversight is not entirely new, as certain predecessor organisations were established some decades ago disasters (Schlumberger and Vijayakumar, 2014).

EASA is considered to be the most advanced ROSO in terms of oversight functions and delegated authority. An agency of the European Union (EU), it was formed in 2004 when it absorbed the functions of the former Joint Aviation Authorities (JAA). EASA members include all member states of the EU, as well as some non-EU countries. The mission of EASA is to promote the highest common standards of safety and environmental protection in civil aviation in Europe. As the safety regulator and advisory body for civil aviation in Europe, it is an independent authority on technical matters and has legal, administrative, and financial autonomy in the EU structure (EASA, 2016).

Air Zimbabwe has direct routes into Europe particularly London, Brussels and Paris. Although it is currently not flying into Europe, its acceptance into European airspace means compliance with EASA safety standards. However, before EASA blacklisted Air Zimbabwe in 2017 due to safety deficiencies, CAAZ had forewarned the national airline based on its safety oversight roles. According to Danga (2017) cited in CAAZ Aviation Magazine Vol 1, it is also critical to note that CAAZ accepts EASA certified aircrafts on its national register, a condition which qualifies it as an aviation disaster management proactive entity.

EASA maintains oversight standards by conducting inspections of member states and by adopting a continuous and risk-based monitoring approach. In that respect CAAZ has always had inspections by certified EASA inspectors. According to Schlumberger and Vijayakumar, (2014) the agency's responsibilities include providing technical advice to the EU for drafting new legislation, implementing and monitoring safety rules including inspections and training in member states, issuing airworthiness and environmental type-certification of aeronautical parts, products, and appliances, providing approval of aircraft design and maintenance organisations, and conducting safety analysis and research. Based on these processes, Air Zimbabwe was blacklisted as earlier warned by CAAZ. The blacklisting of the national airline further strengthened CAAZ's international safety oversight reputation on the promotion of aviation safety.

In line with a 'total system approach', EASA's remit has expanded progressively over time Schlumberger and Vijayakumar, 2014). The organisation's initial competencies were limited only to airworthiness and matters of environmental compatibility, which exposed most airlines to aviation vulnerabilities as these were not providing a comprehensive inspection of aircrafts as prescribed by a 'total system approach'. This was further expanded to include flight crew licensing, operation of aircraft, and safety of third country aircraft. Finally, EASA was also mandated to issue regulations on safety of aerodromes and air traffic management and air navigation services. According to Chaota (2018) cited in the CAAZ Aviation Magazine Vol 2, the authority has implemented the total system approach not only as a response to EASA but as a global aviation management mandate to avoid air crashes.

Zimbabwe's Compliance with Domestic Aviation Disaster Management Culture

CAAZ operates within the general framework of ICAO requirements. These standards span from areas to do with security, safety, licensing of aircrafts as well as their maintenance, search and rescues, air traffic and air navigation. In addition to these standards, there are also local laws and regulations that guide aviation operations. These include the Civil Aviation Act (1998), aviation circulars on operations of Unmanned Aerial Vehicles (UAVs) (2016) and the Civil Protection Act (1989). According to the Civil Aviation Act 1998, CAAZ is instructed to have an organisational structure which includes Regulatory and advisory Services, Airport Management and Development and Air Traffic and Air Navigation Services. These departments are critical in disaster management. The pending amended Civil Aviation Act provides for the split of the aviation authority into two separate companies namely, the Regulatory Authority and Airports Company. The separation's importance viz-a-viz aviation disaster management is the regulatory authority will carry out its safety, security

and maintenance inspection roles which are key to disaster management without conflict of interest. Chikoto (2004) argues that at a national level, the department of civil protection is charged with the onus of coordinating and managing disasters and reducing risks. The sectoral disaster management functions of CAAZ are therefore subordinate to the CPU.

Challenges Faced by CAAZ in Implementing Disaster Preparedness Measures

In a study to determine the importance of training in aviation firefighting operations, Avsec (2017) states that it is critical for aviation fire fighters to have a set of knowledge, skills and abilities specifically focused on the response to aircraft crashes and fires. Such training includes aircraft terminology, types of engines, and types of aircraft, hazards associated with materials used in aircraft construction, basic aircraft operations and aircraft hazards. In this respect, the implementation of disaster preparedness measures can be hampered by lack of training in aviation specific disaster management skills. Relatedly, CAAZ has not been able to conduct ad-hoc training for its fire personnel due to financial constraints characterising the organisation. Additionally, CAAZ abandoned its policy of engaging experts to capacitate its employees with modern firefighting skills. Resultantly, this condition puts CAAZ' s disaster preparedness on the spotlight since firefighting operations are a critical function of aviation disaster preparedness at airports (ICAO, 2009).

On a similar note, Twigg (2015) writes that good coordination is vital. He added that there should be vertical coordination between local and higher authorities and horizontal coordination which happens between different agencies operating at the same level. Disaster preparedness planning does not have to be centralised. There will have to be some centre to coordinate emergency operations, but disasters cannot be controlled in a 'top-down' manner from a single point, and decision-making should be delegated where possible. Where coordination is fragmented and poorly planned, preparedness plans for disaster response will not be without challenges. This is so because response to aviation disasters is multi-sectoral, with different agencies expected to perform different responsibilities. Twigg (2015) also wrote about the unavailability of resources as a challenge to disaster preparedness. His arguments are based on the fact that when a disaster strikes, a variety of goods and services are needed to deal with the crisis.

RESEARCH FINDINGS

Airport's Vulnerabilities and Preparedness to Manage Aviation Disasters

Participants were interviewed on a variety of questions regarding Zimbabwe's preparedness to manage aviation disasters. On the question regarding the knowledge of disaster preparedness, all respondents who were interviewed showed a general understanding of what disaster management in general and preparedness in particular is about. According to their responses, there seemed to be a collective massage that disaster preparedness at the Robert Gabriel Mugabe International Airport ensures that systems are in place to deal with aviation disasters in the shortest possible time in order to save lives and property. They mentioned the existence of an airport emergency preparedness plan which they said acts as the general guide to measure different stakeholders' preparedness to respond to aviation disasters. Respondents also showed a great deal of understanding of the constituting departments to the emergency preparedness and their various responsibilities. They spoke about disaster preparedness plans, training of human capital, logistical support and provision of funding as critical disaster preparedness measures put in place at airports in fulfilment of ICAO minimum standards. However, the responses given contradict the general observation which precipitated this study about lack of preparedness to manage aviation disasters as some as there are no readily available resources to carry out refresher training of personnel involved in disaster preparedness related duties. The research discovered that the general knowledge is available, but it is the financial backing that lacks to meet the general requirements.

Relatedly, an interviewee from aviation security went a step further to highlight the various types of emergencies that can arise at airports, to include hijackings, bomb blasts, and air crash on and off airports and disease outbreaks. On a similar note, a respondent from fire department went a step further to elaborate the preparedness measures in the context of fire response and indicated that the fire department is the first port of call in aviation disaster response and have ICAO minimum standards in respect of the number of fire tenders which is informed by the size of aircrafts that lands on an airport and the minimum number of personnel. He said RGMIA is required

to have a minimum of three operational fire tenders with certain quantities of extinguishing medium and a certain number of personnel to man the vehicles. Other issues include cutting equipment and training of fire personnel.

Asked about how vulnerable the RGMIA to aviation disasters is, an interviewee from the executive management team responded by giving a background that Zimbabwe has not had a serious aircraft accident in its airspace that could have led to an aviation disaster. He cited the Mutare air crash which claimed five casualties. The interview said, *"The aircraft accident which claimed five lives in Mutare was caused by bad weather".* However, he was quick to point out that although lives were lost and equipment destroyed, the accident, did not qualify to be termed an aviation disaster. He also highlighted in response, the Gwanda helicopter accident which claimed one life and added that what almost came to become a disaster was the incident of the Air Zimbabwe operated MA60 which hit a warthog in 2009 as well as the Egypt Air which lost one of its engines on take-off at RGMIA. He said on both occasions pilots averted calamitous disasters by navigating the aircrafts to safety. The respondents' reasons of describing the Mutare air crash which claimed five lives not as a disaster is based on Zimbabwe's legal definition which defines a disaster as a catastrophic event that claims ten or more lives.

He gave out that in terms of vulnerability, there are certain actions the aviation authority is taking to ensure that aircraft accidents which leads to aviation disasters do not occur citing wild animal encroachments management as an example. He indicated that CAAZ learnt the hard way after an Air Zimbabwe operated MA60 hit a warthog in 2009 on take-off at the RGMIA prompting the current deployments of wildlife rangers specifically to reduce not to eliminate wildlife incursions. Asked how vulnerable RGMIA is given the absents of a radar, he said procedural control which uses the physical map to separate aircrafts laterally or horizontally, is an acceptable ICAO means of airspace management adding that radar comes in when you have dense traffic. He said in situations like we have in Zimbabwe, radar systems are a " nice" to have, while in circumstances of denser traffic like at the Oliver Tambo International Airport in South Africa, it is a must to have for expeditious manoeuvring and controlling of traffic. His position was that the absence of a radar exposes the airspace from a security point of view which is a responsibility of relevant security apparatus of government not from a safety point of view which would to aviation disasters. He justified his position by saying that no pilot would fly blind because they do not want to die in air crashes that they cause because the disaster would take their lives as well unless if they are suicidal. In this respect, he said aviators would communicate with other aircrafts that are in the vicinity because aircrafts have in build technologies that allows for that. He added that it would strange to find someone that would across Zimbabwe's airspace with aeronautical notification because chance of that aviator causing an aviation disaster becomes very high. He therefore said vulnerabilities to aviation disasters in the absence of radar are remote.

Relatedly, an interviewee from aviation security indicated that "*The vulnerability of airports arises from the fact that there are large concentration of people under one roof and that any hazard risk that materialises has the probability of causing loss of human life and damage to property, adding that the RGMIA is not an exception"*. Commenting on the airport's vulnerability to disasters, he said that, *"The airport might be in a good steady in terms of preparedness to manage aviation disasters citing the availability of fire tenders, availability of trained personnel and official synergies with relevant stakeholders such as City of Harare Fire Department, Air Force of Zimbabwe Fire department as well government and private health providers".* He said initial stages of disasters may face challenges in immediate responds given the inherent co-ordination pitfalls arising from the high number of responding stakeholders. He again mentioned security related hazards such as hijackings, bomb blasts or terrorist attacks as well catered for given the contiguity of the Manyame airbase who can respond within ICAO prescribed response time.

Responding to the same question, an interviewee from the fire department cited the period of take-off and landings as the phases that are susceptible to air crash hazards that would lead to disasters. *"Take-off and landing times are the most vulnerable periods during flight operations".* For that reason, ramp safety official inspects the runaway minutes before take-off and landing, thereby reducing hazards of wild animal incursions and bird strikes at the RGMIA. He added that these incidents happen on the runway or within the 8km radius of the airport. For this reason, the RGMIA emergency management plan covers the 8km radius. He also mentioned the terminal building on the basis that it carries large numbers of people and if an incident like fire outbreaks or security related incidents happen, there are bound to be casualties. It was also mentioned that the aircraft itself is vulnerable to fire hazards given the large volumes of highly flammable fuels they carry at any given time with

the largest aircraft carrying more than one hundred and seventy thousand litres of jet A1 fuel. He went on to say jet A1 fuel is highly volatile and the need for maximum precautions during fueling cannot be over emphasised.

A respondent from FSS commented that Zimbabwe is vulnerable to aviation accidents which can lead to disasters stating that, *"We are having short comings in initial, continuing and any such refresher training on special approvals".* As an analysis the respondent meant the approving of equipment in the aircraft to qualify for such commercial operations citing reduced vertical separation minimum and performance-based navigation aids as examples. He pointed out that the overall result of an accident investigation is not only to get the cause but to avoid recurrence adding that safety recommendations become the critical part of aviation disaster preparedness. On the same question the responded further said that the department has capacity gaps and as such they perform oversight functions on tasks, they are not qualified to do which is against ICAO standards on airworthiness, adding that, *"We rely on information from operators which information is conflicted because they can choose what to and what not to give".* Such shortcomings are a recipe for disaster.

Causes of Aviation Accidents

Questions on to contributing factors to aviation accidents and the measures being put in place by the authority were asked to three categories of respondents, namely pilots, flight safety standards inspectors and air traffic control. All respondents pointed the causes of aircraft accidents to human factors which they said are broad and can be further broken down into fatigue, poor crew management, pilot incompetency and adverse weather conditions, amongst others. Respondents went on to explain that it is important to understand the causes of aviation crashes in order to come up with proper aviation disaster preparedness measures. One pilot indicated that *"Human factors such as fatigue are mitigated by way of a fatigue management program implemented by organisations on airmen and people on the ground to include operators such dispatchers and engineers"*. In their response, pilots gave a historical origin of the crew resource management programs which they said originated in the USA after the Tenerife air disaster where accident investigators found that a gulf between the captain and the first officer with the latter not being able to question the captain's authority yet he was sure the captain was insisting on taking off under uncomfortable conditions which resulted in the crush that killed more than 500 people. They therefore said the crew resource management allows a flatter structure that allows both views to be heard. They said crew resource management has evolved to include threat and error management where the crew looks at risk collectively and mutually agree on mitigating responses. They said this is done by the aviation authority ensure that operators have documented procedures in place and that they have implementing processes.

On the same question, a FSS Inspector responded that, *"The aviation sector is a highly regulated industry managed by ICAO and the organisation gives civil aviation authorities guidelines to monitor issues to do with human factors as a cause of accidents".* He said ICAO requires that all personnel that work on aircrafts such as engineers, pilots and dispatchers go through human factors training on an annual basis before issuance of a license. In reference to the RGMIA he said human factors courses are being conducted as per the dictates of ICAO.

Pilots and FSS Inspectors pointed out that the causes of aviation accidents are a result of human factors. One pilot and FSS inspector respectively said, *"more than sixty percent of aviation disasters are a result of human factors".* Despite the coherent responses, RGMIA remains vulnerable to aviation accidents that cause disasters as observed in the Tenerife air disaster where the pilot failed to take advice from the first officer. The fact that pilots have the ultimate authority during a flight means they may decide to ignore valuable advice from the first officer. In that respect there should be continuous interaction between the pilot and the first officer during flights in order to avoid a similar case like the Tenerife air disaster. On the issue of human factor training given to dispatchers, engineers and pilots by the authority, the financial constraints that haunt the organisation means that it lacks capacity to conduct regular training programs which compromises RGMIA safety. As such, this leaves the airport vulnerable to accidents which can lead to a disaster.

Compliance to Aviation Disaster Management Legal Instruments

The question on domestic, regional and international legal instruments that focuses on aviation disasters and

how CAAZ is implementing them was posed to a member of the executive management and directors in the Civil Protection Unit. A CAAZ official responded by saying that, *"Issues of disaster preparedness at airports are an international requirement as stipulated in ICAO annexes that deals with search and rescue operations, the setting up of airport emergency plans and the carrying out of emergency exercises such as tabletop and full-scale emergency exercises"*. He went on to say that, *"ICAO sets out in the annexes the format of the plans, the stakeholders to constitute the emergency plans and the actual exercises as well as the frequencies with which the exercises should be conducted"*. The respondent indicated that governments domesticate the ICAO requirements into policies, procedures or regulations that are given force by way of statutory instruments. Furthermore, respondent said governments can also enter into bilateral agreements with neighbouring countries on matters of aviation disaster management.

In this respect, he said, *"To date; Zimbabwe has standing bilateral search and rescue agreements with South Africa and Zambia whilst an agreement with Mozambique which was prompted by the crash of the Mozambique registered aircraft in Mutare is work in progress"*. Respondent further said SADC is also working on a regional Search and Rescue framework for member countries. He said these agreements are encouraged by ICAO. He gave out that bilateral and regional disaster management agreements help member countries in the sharing of technical manpower, equipment and information which is important when coming out with aviation disaster preparedness plans for airports. He went on to say that Zimbabwe has not capacity to lift a B777-200 from the runway in the event of a crush at its international airports including RGMIA adding that the bilateral SAR agreement with South Africa is such that the country would outsource the uplifting equipment from South Africa. Meanwhile, respondents from the CPU remarked that the department guides all Disaster Risk Reduction (DRR) efforts in Zimbabwe which include technological disasters. One respondent contented that, *Whilst each sector, including health and aviation have sector specific disaster management plans, the overall administrator of the civil protection act is the department of CPU".* He acknowledged that more needs to be done to mainstream the aviation sector's disaster management related activities into national plans and programmes and cited awareness activities that the authority do to communities around the airport which he said can be done jointly with CPU.

As Zimbabwe has a vision to be regional aviation hub, a condition that will result in more and large aircrafts in the model of B777-200 and AirbusA380 to land in its airports, the country should acquire the necessary equipment that quickens disaster response mechanism as indicated by one respondent who said that, "*Currently our airports do not have the capacity to lift a B777-200 and those of similar size from the runway in the event of a crush, as a disaster preparedness measure".* Additionally, although Zimbabwe might have existing bilateral and regional arrangements for aviation disaster management is not ideal as the support may take time to arrive resulting in loos of and life and property.

Disaster Preparedness Challenges

In their responses, there was an overwhelming concurrence among stakeholders that financial challenges were the Achilles heel of disaster preparedness. The financial challenges were also blamed for the lack of modern generation equipment in fire fighting for search and rescue, radar and aeronautical systems for safety aerospace management to prevent accidents which causes disasters. Respondents also mentioned the in-availability of the radar services and the existing obsolete communication equipment which experiences repeated breakdowns as serious challenges to the implementation of disaster preparedness measures. Financial challenges are also blamed for the shortage of as CAAZ lack the capacity to send employees to external aviation training schools to learn how others are doing it. Meanwhile, a respondent from ramp safety pinpointed the non-availability of what he *termed "a special vehicle fitted with sirens to chase away birds and wildlife encroachment before take-offs and landings"* adding that the one which they use is an ordinary vehicle shared by other sections for different responsibilities. Same respondent also went a step further to cite the no-availability of special equipment to lift medium and large body aircraft from the runway in the event of a crash and added that the equipment is sourced from South Africa.

A respondent in the FSS indicated structural distortions in the civil aviation management authority as creating serious operational challenges to do with the general aviation disaster management discourse. He argued that the FSS audits the RGMIA's compliance with ICAO defined standards, yet the ultimate consumer of the audit results is a general manager who is also responsible for operations of the airport. Inspectors argued that this creates

conflict of interest because he cannot fail an airport which he manages. One respondent said that "*there is lack of commitment from stakeholders who constitutes the airport's emergency operations committee involved in the planning and execution of emergency exercises that include table tops and full emergency exercises".* He said the lack of interests manifest into challenges of coordination and duplication of responsibilities during actual exercises because stakeholders are poorly informed of what is expected of them.

CONCLUSION

In respect of CAAZ's preparedness, the research concluded that CAAZ is not adequately prepared to manage aviation disaster. Lack of financial resources has impacted negatively on the organisation's ability to retool and staff development. Requisite emergency exercises are not done as per schedule.

The global aviation sector faces a multiplicity of challenges. Prominent among them are human factors, organisational, environmental and politically induced conflicts. In this particular research, the conclusion was that financial constraints leading to lack of capacity to maintain infrastructure, lack of modern generation aerospace managements systems that include radar and aeronautical communication systems affect disaster preparedness. The research also concluded that the huge response from regional and international airlines pose a challenge to CAAZ which is not simultaneously responding to the expanding business in the aviation sector.

RECOMMENDATIONS

Based on the research findings and conclusions, the research recommends the following; **Funding**. The lack of funds for emergency exercises and the purchase of equipment is the major inhibiting factor to effective disaster preparedness and management. CAAZ must prioritise safety issues when allocating resources. Conducting full emergency exercises within the ICAO stipulated two-year frequency will only be possible if CAAZ commits itself financially because the exercises can be a huge cost centre. Additionally, the authority can seek partnerships under the Public Private Partnerships (PPP) programmes as a way of creating additional lines of funds for aviation safety issues.

Equipment. Yet another common finding by this research is the challenge of lack of modern equipment that enhances disaster preparedness and the overall disaster management at the RGMIA. As such, it is recommended that CAAZ should ensure the availability of modern and fit for the purpose equipment that can be used to either prevent or manage disasters. This can be achieved through allocation of a fixed percentage of annual revenues to cater for safety issues. Along the same line, it is recommended that when government or quasi government departments involved in disaster preparedness are procuring equipment such as fire tenders, it should be done from the same manufacturer to allow easier adaptation by users.

Capacity building. Lack of skills by various stakeholders constituting the airport emergency committee emerged as a major challenge. Therefore, this study recommends that CAAZ should conduct joint training and refresher courses in disaster preparedness related areas with other stakeholders to acquire and perfect of skills.

REFERENCES

1. Allan, J. (2000). *Bird Strikes as a Hazard to Aircraft: A Changing But Predictable and Manageable Threat.* UK Central Science Laboratory.
2. Australia Transport Safety Bureau (2002). *The Hazard Posed to Aircraft by Birds: Aviation Safety.*
3. Ayres, M. (2009). *Guidebook for Airport Safety Management Systems*. Applied Research
4. Associates and International Safety Research inc. [Online]. Retrieved from www.national-academics.org/trb (20/04/2018).
5. Baum, H. (2010). *Accident causes*. Aviation law attorneys. [Online]. Retrieved from www.airplanecrash-lawyer.com (20/04/2018).
6. Blokpoel, H. (1976). *Bird hazards to aircraft problems and prevention of bird or aircraft collisions.* Clarke, Irwin & Co. Ltd. Canadian Wildlife Service/ Publishing Centre, Supply and Services Canada.Boeing Commercial Airplanes (2006). 2006 *statistical summary of commercial jet airplane accidents, worldwide operations* 1992-2001. Seattle: Boeing.

7. Bolin, B. L, Quarantelli, L. E. and Dynes, R. R (2006). "*Race, Class, Ethnicity and Disaster Vulnerability"* in Havidán Rodríguez, Pp. 113-29. Handbook of Disasters. Spring.
8. Caffera, P. (2003). "*Surface-to-air missile: We were warned"*. The Journal of Airport and Airline Security Vol. 9 Issue 1 of February 2003. London: Aviation Security International.
9. Carroll, J. S, (1998). *Organisational Learning Activities in High-Hazard Industries: The Logics Underlying Self-analysis*. Journal of Management Studies, Vol 35 Issue no. 6, 699-717.
10. Chaota, D. (2018). *Full Scale Emergency Exercise*, CAAZ Report, July 2018.
11. Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (4th Edition). Thousand Oaks: Sage.
12. Devine, J. (2009). *Causes of Airplane Accident*. [Online]. Retrieved from http://ezinearticles.com (26/10/2010).
13. Dismukes, R. K., Berman, B. A., and Loukopoulos, L. L. (2007). *The Limits of Expertise: Rethinking pilot error and the causes of airline accidents*. Aldershot: Ashgate.
14. Dempsey, P. S. (2008). *Public International Air Law*, McGill
15. Gero, D. (1993). *Aviation Disasters: The world's major civil airliner crashes since 1950.* Hayness Publishing, London
16. Groff, L. S., and Price, J. M. (2006). *General aviation accidents in degraded visibility: A case control study of 72 accidents*. Aviation, Space, and Environmental Medicine, 77, 1062-1067.
17. Humphreys, W. J. (1930). *Meteorology and its importance to aviation*. Monthly Weather Review, 58, 196-197.
18. ICAO. (2003). *International Civil Aviation Organization Resolution A 33-16.* [Online]. Retrieved from www.icao.org (25/04/2018).
19. ICAO. (2015). *ICAO Safety Report: A co-ordinated, Risk based Approach to Improve Global Aviation Safety.*
20. ICAO. 2004. *International civil aviation organization, global safety plan.* [Online]. Retrieved from. www.icao.org (25/04/2018).
21. Kay, P. (2016) *EASA Annual Safety Review*.
22. Krasner, H. (2009). *The Causes of Aircraft Accidents. Why do most planes crash, what are the most common reasons* [Online]. Retrieved from www.suite101.com (4/11/2010).
23. Krey, N. (2007). *The Nall Report 2007: Accident trends and factors for 2006*. Frederick, MD: AOPA Air Safety Foundation.
24. Kothari, C.R. (2007). *Research Methodology: Methods and Techniques* (2nd Revised Edition). Jaipur: New International Publishers.
25. Kumar, U and Malik, H. (2003). *Analysis of fatal human error aircraft accidents in IAF*. Ind J Aerospace Med 47 (1): pp30-36.
26. La Porte, T. R. (2006). "*High Reliability Organizations: Unlikely, demanding, and at risk"*. Journal of Contingencies and Crisis Management 63(4).
27. La Porte, T.R, Consolini P. (1991). "*Working in practice but not in theory: Theoretical challenges of High-Reliability Organisations"*. Journal of Public Administration Research and Theory 1: 19-47
28. La Porte, T.R, Rochlin G. (1994). "*A Rejoinder to Perrow"*. Journal of Contingencies and Crisis Management 2(4).
29. Mavhura, E (2015). *Disaster Legislation: A critical review of the Civil Protection Act of Zimbabwe.* Bindura University.
30. Meyer, G. (2014). *IATA Safety Report*, 51st Edition.
31. Meyer, G. (2017). *IATA Safety Report*, 51st Edition.
32. Obwaya, R.E.O. (2010). *Disaster Risk Reduction Strategies in Preparedness: A case study of Jomo Kenyatta International Airport (JKIA) Nairobi Kenya*. Published Thesis, University of Free State.
33. Pidgeon, N.F. (1997). *The limits to safety? Culture, politics, learning, and man-made*
34. *disasters*, Journal of Contingencies and Crisis Management, 5(1), 1-14.
35. Perrow, C. (1999). *Normal Accidents: Living with High-Risk Technologies.* Princeton, N.J.: Princeton University Press.
36. Reason, J.T. (1990). *Human Error*. Cambridge University Press, Cambridge.
37. Rasmussen, J. (1997). "*Risk management in a dynamic society: A modeling problem"*. Safety Science 27(2/3): 183-213.

38. Rasmussen, J, Svedung. I. (2000) *Proactive Risk Management in a Dynamic Society.* Swedish Rescue Services Agency.
39. Roberts, K.H. (1990a). "*Managing high reliability organisations"*. California Management Review 32(4): 101-114.
40. Roberts, K.H. (1990b). "*Some characteristics of one type of High Reliability Organisation"*. Organisation Science 1(2): 160-176.
41. Roberts, K.H. (1993). *New Challenges to Understanding Organisations*. New York: Macmillan.
42. Rochlin, Gene I., Todd R. La Porte, and Roberts, K.H. (1987). "The self-designing High Reliability Organisation". Naval War College Review, Autumn.
43. Sagan, S. (1995). The Limits of Safety. Princeton University Press.
44. Sagan, S. (2004). "*The problem of redundancy problem: Why more nuclear security forces may produce less nuclear security"*. Risk Analysis 24: 909-26.
45. Saunders, M.N.K (2015). *Research Methods for Business Students: 7th Edition.* Pearson Education, London.
46. Swabrick, N. (2009). *Air crashes, causes and consequences.* Te-Ara encyclopaedia of New Zealand, [Online]. Retrieved from www.teara.govt.nz/en/air-crashes (26/10/2010).
47. Schulmberger, C. E. and Vijayakumar, S (2008). *Regional Safety Oversight Organisation: Service Provider or More? The Case of Pacific Aviation Safety Office*.
48. Thiele, R.D. (2014). *Challenges and Opportunities in Search and Rescue Operations Post MH370/MH17.*
49. Turner, B. A. and Pidgeon, N.F. (1997). *Man-Made Disasters*, 2nd Edition., Oxford: Butterworth Heinemann.
50. Twigg, J. (2004). DRR: *Mitigation and Preparedness in Development and Emergency Programming.*
51. Twigg, J. (2015). DRR: *Mitigation and Preparedness in Development and Emergency Programming.*
52. Wisner, B. Blakie, P. Cannon, T. and Davis, I. (2004). *At Risk: Natural Hazards, People's Vulnerability and Disasters, 2nd Edition*., London: Routledge.