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BIRD STRIKE OCCURRENCE AND CONTROL AT MURTALA MUHAMMED INTERNATIONAL AIRPORT, LAGOS, NIGERIA

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Abstract

Bird strike is a problem that costs the global aviation industry over one billion US Dollars annually and endanger human lives. Nigeria, like every other country is not exempted from this menace. This study focuses on bird strike hazard at Murtala Muhammed International Airport (MMIA), Lagos. The study specifically examined the incidence of reported bird strikes from 2004 to 2014 and the control facilities and measures used at the airport. Data were obtained from the Nigerian Civil Aviation Authority (NCAA), Wildlife Hazard Control Unit of Federal Airports Authority of Nigeria (FAAN) and the Environment and Airport Safety Management Department of MMIA. The data were analysed using descriptive statistics and presented in tables with percentages and graphs. The results indicate that the highest number of strikes (18%) occurred in 2009 for the period under study. Almost 60% of the strikes occurred during the day time, while 58.4% of the strike cases were associated with the landing and take off phases. Results also show that bird strike management measures used at MMIA include habitat management techniques involving adoption of long grass policy (150-200mm height) and grade improvement. Others include exclusion techniques such as perimeter fencing and use of anti-perching spikes on airfield infrastructure and use of pyrotechnics like bangers and scarers to disperse birds from the airfield. It is recommended that airports in the country should embark on habitat management programmes that will make airports less attractive to birds and other wildlife. In addition, while there is the need to properly train and equip bird control officials at the nation's airports, modern forensic technology should be adopted for proper identification of bird remains for more effective control.

KEYWORDS: Aircraft; Airfield; Birds; Wildlife; Control; Collision.

INTRODUCTION

Collision between aircraft and animals particularly birds, is a problem that has continued to gulp lots of funds and endanger human lives though, the menace remains unnoticed by majority of air travellers and the society at large. Since the first recorded incident of bird strike in 1905 in Ohio, USA and the first recorded human mortality from collision between aircraft and bird in Southern California, USA in 1912, hundreds of aircrafts have been destroyed and hundreds of human lives lost to bird strikes (Cleary and Dolbeer, 2005). For instance, from 1960 to 2004 not less than 122 civil and over 300 military aircraft were destroyed; while nearly 300 civilians and more than 150 military personnel lost their lives to bird strike worldwide

(Cleary and Dolbeer, 2005; Shobakin, 2009). The greatest loss of lives directly attributed to bird strike occurred on 4th October, 1960 when a Lockheed L-188 Electra plane was struck by a flock of birds during take-off, damaging all four engines. The aircraft crashed into the Boston Harbour, USA resulting in the death of 62 of the 72 passengers on board. On the average, an air crash occurs every eighteen months as a result of a bird strike related incident (Thomas, 1992).

Whenever birds and aircraft collide, the birds are most often at the losing end, but on many occasions the aircraft also suffer damages. Crushed engines, smashed windscreens and dented airframes are some of the probable damages to aircraft resulting from bird strikes. It is estimated that bird strikes cost the international aviation industry at least US \$1.2 billion each year. In the United States alone, the menace costs the civil aviation industry not less than \$500 million in damages and other related cost and more than 500,000 hours of aircraft down time annually (Cleary and Dolbeer, 2005; Yap, 2014). Given that the United States Federal Aviation Administration (FAA) estimates that only 20% of all bird strikes are reported, this cost could potentially be much higher than reported. As air traffic continues to grow globally, and as airport development increasingly encroach into the natural habitats of birds and other animals, bird strike remains an important issue for aviation safety (Yap, 2014).

Nigeria, like every other country is not exempted from occurrences of bird/wildlife strikes. For example from 2005 to 2010 a total of 209 bird strikes were reported in the country (Usman *et al*, 2011). The Airline Operators of Nigeria (AON) claimed that their members lose over \$180million to bird strike incidents in the country yearly due to damages to aircraft (News Express, 2015). In 2006 alone, bird strikes caused 115 air incidents in the country and accounted for 17.4 per cent of the total air incidents that year. It is estimated that this has increased to 24 per cent due to increase in the number of aircraft operating in Nigerian airspace (This Day Online, 2010; Dukiya and Ahmad, 2014). Various stakeholders in the Nigerian Aviation industry have continued to express fear that inadequate attention paid to the menace of bird strikes might increase cases of air crashes in the country and have constantly called for concerted efforts to significantly curb it.

Airports in Nigeria have also experienced various other incursions from terrestrial wildlife and domestic animals some of which have resulted in collision with aircraft. For instance, in 2005 an Air France aircraft with over 200 passengers collided with a herd of cows while landing in Port Harcourt airport (AllAfrica.com, 2005). Also, in March 2011 another aircraft collided with a herd of cows and goats at Bauchi airport (AllAfrica.com, 2011).

Prevention of bird strikes begins at the airport because over 80% of cases occur in airports environment during take-off, final climb, approach landing and taxiing phases of flight (Dolbeer and Bucknal, 1994). Meanwhile, due to the little information on bird/wildlife strike occurrence in

Nigeria, it is still difficult to properly establish risk to humans and wildlife that may exist due to bird strikes. Murtala Muhammed International Airport (MMIA) and some other airports in the country have been identified as being particularly prone to birds/wildlife risk (Nigerian Civil Aviation Authority (NCAA), (2016). This study focuses on MMIA which is the busiest and most important airport in Nigeria. For instance, it accounted for almost 40% of domestic and over 70% international passenger traffic in the country in 2015. In addition, four times as many international flights went through MMIA than Abuja Airport. This study therefore examines bird strike hazard at Murtala Muhammed International Airport and the control measures put in place to control it. The specific objectives were to:

- i. examine incidents of reported bird strike at the airport from 2004 to 2014;
- ii. examine the bird strike control facilities and management measures used at the airport.

2. Bird Strike Definition and Control Measures

Birds/wildlife strike simply refers to a collision between a bird (including bat) or a terrestrial animal and an aircraft. A bird strike sometimes called birdstrike, bird ingestion (for an engine), bird hit, or BASH (for Bird Aircraft Strike Hazard) is a collision between an airborne animal (usually a bird or bat) and a human-made vehicle, especially aircraft (Gard *et al.* 2007). Although, sometimes strictly defined as a collision between a bird and an aircraft in flight or on a take-off or landing roll, the term is often expanded to cover other wildlife strikes with ground animals (SKYbrary Aviation Safety, 2016). Bird strike definition cover all reported collisions between a bird or other wildlife and an aircraft for which evidence in the form of a carcass, remains (also known as snarge) or damage to the aircraft is found, any wildlife (bird/animal) found dead on an airfield where there is no other obvious cause of death (such as strike by ground vehicles in the operational area) and any reported collision between a bird or other wildlife and an aircraft for which no physical evidence is found (Gard *et al.* 2007; Haruna, 2011).

Most accidents occur when there is a collision involving a bird (or birds) and the windscreen or a bird(s) is/are sucked into the engines of aircraft. The nature of aircraft damage from bird strikes differs according to the size and speed of aircraft and the size of the bird involved. For instance, collision with a single large bird such as geese has the potential to cause a severe damage to the aircraft which may at times lead to the total loss of the aircraft, its crew and passengers. This is due to the high kinetic energy especially when such bird is ingested by the engines of the aircraft (SKYbrary, 2016).

Although, bird strikes have been recorded up to a height of 37,000 feet, 97% of bird strikes occur at lower elevation associated with descent, approach, landing, take-off and climb phases of flights. While bird strikes at the en-route phase of flights is much less frequent (3%) due to the high altitude (US Federal Aviation Administration (US FAA), (2015). Different

periods of the day are also associated with different rates of occurrence of bird strike. For instance, in the United States 62% of bird strike involving civil aircraft occur during the day, 29% occur at night while the remaining 9% occur at dawn (US FAA, 2015). Generally, birds do not intentionally get in the way of aircrafts during flights; rather they usually avoid aircrafts whenever possible. However, technological advances have made aircrafts quieter and faster, making it more difficult for birds to avoid them (Yap, 2014).

The damage caused by bird strike to the global aviation industry has resulted in the adoption of numerous control or management schemes to combat this menace. Habitat modification, people/vehicle, lights, resource protection, exclusion, audio repellents, use of model aircraft and killing are some of the major control measures employed in the aviation industry.

Habitat modification involves designing and managing the airport habitat in such a way that conditions that encourage attraction of birds are eliminated or minimised. This involves making the airport environment less conducive as source of food, place of shelter and roosting area. Measures like manipulating the height of vegetation, removal of trees and improvement of drainage within the airport environment are used (International Bird Strike Committee (IBSC), 2006). However, it is advisable that habitat modification be aimed at the problem species because, the affect may extend beyond targeted birds and affect other bird species and animals. In addition, since every airport environment is unique, measures should be based on appropriate ecological research of the airport and its surroundings. Notwithstanding, it is an effective and enduring way of preventing the presence of birds. Consistent management of vegetation and water is very necessary for success to be recorded with this technique (Cleary and Dolbeer, 1999; Wired Magazine, 2005; Desoky, 2014).

People/Vehicle measures like slow arms waving to imitate the flight of a large bird of prey and similar actions are also in use. They are applied in various forms ranging from people standing in patrol vehicles to fixing imitation wings on moving vehicles. Even the mere presence of people or the bird patrol vehicle is enough to scare away some species. Persons holding shotguns (or even models) have also been successfully applied, particularly where hunting is common practice (Stenman, 1990).

Various kinds of light source have been used to scare away birds. The most effective are search, rotating and flashing lights, at times used in combination with mirror systems (Godsey, 1997). Aircraft are commonly equipped with flashing lights to make them more easily detectable to birds so that they could avoid them. Patrol vehicles also have flashing lights mounted on them. A strong search light beam can scare birds at a distance up to 800 m. However, blue light seem to be more effective than other colours, maybe due to a higher sensitivity of the bird's visual senses

to 'blue' wavelengths. Other forms of light like strobe and laser has been used with some degree of success (Stenman, 1990). Approach-lights alongside landing strips have also been found to reduce bird strike by 50% during daylight. Probably, they improve a bird's timely detection of an approaching plane. However, care should be taken with the use of lights, because some migrating birds are known to be attracted by lights at night (Thorpe, 1996).

Exclusion techniques involve denying or discouraging access to attractive areas by using physical barriers. Such barriers could be used for buildings, open water and landfills. Airport buildings may be used by birds as roosting or breeding sites. Bird anti-perching spikes can be fitted on ledges, signage boards and airport equipment to prevent birds from using them as perching or roosting places ((Froneman and Rooyen, 2003). Favoured areas, such as ledges, setbacks and flat surfaces can be closed off with netting, screening, spikes and wires. Curtains of heavy plastic sheets can also be used to prevent the use of openings or doorways while ceiling made with nets will deny bird access to areas under roofs or shelters (Blokpoel, 1976; Cleary and Dolbeer, 1999). Wire mesh and nets can be used to make water bodies such as ponds or lakes and even landfills inaccessible (Cleary and Dolbeer, 1999).

Audio repellents are also used to chase birds away from the runway and its vicinity. Sounds are made by using pyrotechnics, propane gas cannons or bioacoustics and shell crackers to scare away birds (Blokpoel, 1976 and IBSC, 2006).

The use of drones (remote-controlled model aircraft) shaped in the silhouette of a bird of prey, have been used successfully in the Netherlands, Canada and France. While the shape, colour and noise of the model were found not to influence results, the way the models were piloted was found to be most significant (Stenman, 1990).

Many airports particularly in the developed world now use Bird Strike Avoidance Radar systems (BSAR) that can detect and track birds many kilometres away. Some like the Merlin Aircraft Bird Strike Avoidance Radar also have acoustic devices for deterring birds from moving close to airport approach and departure corridors. In addition they utilize Geographic Information System (GIS) technology for analysing and correlating bird habitat, breeding and migration characteristics for effective control of bird strike. Some airports that are using this system with commendable degree of success include: Louisville International Airport, Kentucky, USA; Riga International Airport, Latvia; Modlin-Warsaw International Airport, Poland; and King Shaka International Airport, Durban, South Africa (Kelly *et al.*, 2007; DeTecl, 2016).

In extreme cases killing is used to manage the population of birds in airport vicinity. Killing is often targeted at specific problematic species of birds particularly when numbers are

increasing rapidly. Although, this measure is known to be effective at local breeding colonies it is expensive and could have adverse effect on the ecosystem (Cleary and Dolbeer, 2000). In situations where birds constitute serious danger, killing or capturing is used to immediately eliminate the threat. However, this method is normally used as a last option in bird control. The major method of killing is by shooting. Other methods include lethal trapping, poisoning and destruction of eggs or nests (Stenman, 1990; Dolbeer *et al.*, 2003). The effectiveness of this method is controversial. For instance, the experience at New York airports where about 70,000 birds were killed from 2009 to 2016 have shown that rather than reducing strikes, more strikes have been recorded in the three airports. However, this may have been due to more diligent reporting of strike incidents (Portland Press Herald, 2017).

3. MATERIALS AND METHODS

3.1. Study Area

Murtala Muhammed International Airport is located within Ikeja Local Government Area and lies almost 20km southwest of metropolitan Lagos. The airport which covers a total area of about 1.5 hectares, lies on latitude $6^{\circ} 34' 38''\text{N}$ and longitude $3^{\circ} 19' 16''\text{E}$ at an elevation of 40 metres above sea level. The area is located within the tropical savannah climate (Aw) of the Koppen-Geiger classification and has a tropical wet and dry climate that borders on a tropical monsoon climate (Climate-Data.org, 2017). Lagos experiences two rainy seasons with the heaviest rains falling from April-July and a weaker rainy season in October and November. The temperature of MMIA is highest during the dry season and lowest during the rainy season with the mean daily maximum temperature ranging between 32.9°C and 27.8°C . The mean daily minimum temperature ranges between 23.2°C and 21.5°C . The reference temperature for the aerodrome is 31.3°C ; mean annual rainfall is about 1565mm while the relative humidity is normally over 80% (Oduntan *et al.*, 2012).

Different land-uses exist within and around the airport premises including large areas of vegetation cover (see Figure 1). An expanse of mowed grassland within the airport premises close to the aerodrome is a good attraction to birds that depends on earthworms, snails, slugs, spiders, millipedes, and other insects (especially larvae) present in grasses and the underlying soil. Egret, Heron, Lapwings and Pied-crows occur in large flocks to feed on these soil invertebrates at the aerodrome. Carnivorous birds like kites and hawks that feed on small mammals such as rodents are also common. These areas of vegetation cover in the vicinity of the aerodrome constitute attraction to birds and wildlife to the airport environment and are likely to encourage bird strike incidents. In addition, waste generated by the numerous restaurants and

other local food vendors within the airport terminals, waste from in-flight and terminal catering areas, litterbins in car parks and viewing terraces also have high tendency of attracting birds and other animals to the airport environment.



Source: Google Maps (2016)

Figure 1: Satellite imagery of Murtala Muhammed International Airport

3.2. Data Collection

The data for the study were mostly obtained from the Nigerian Civil Aviation Authority (NCAA). They were largely extracted from the bird/wildlife strike log book which contains records of reported strikes. Information on aircraft operator, model of aircraft, registration number, date of incident, local time, runway, phase of flight, part of aircraft struck, part of aircraft damaged, effect on flight and type of bird species involved were extracted for MMIA. Incomplete records were filled in with data from NCAA (2015). Information on equipment and management measures for controlling bird strikes were obtained with a specifically designed questionnaire from the NCAA, Wildlife Hazard Control Unit of Federal Airports Authority of Nigeria (FAAN) and the Environment and Airport Safety Management Department of MMIA. The data were analysed using tables, percentages and graphs.

4. RESULTS AND DISCUSSION

4.1. Bird Strike Incidents at MMIA from 2004-2014

The data collected show that a total of 113 cases of bird strikes were recorded at MMIA from 2004 to 2014. No case of terrestrial animal strike was recorded at the airport within the period. It revealed that, the highest number of incidents occurred in 2009, when 21 strikes constituting 18.6% of the total incidents in the 11 year span occurred (Table 1). As seen in Table 1, high incidence of birds strikes were also recorded in 2012, 2013, and 2010 with 15.9%, 15%, and 12.4% of the strike incidents respectively. The year 2008 however, has the least (3) strike cases constituting 2.7% of recorded strikes. The month of March has the highest strike occurrences with 22 incidents making up 19.5% of all recorded strike cases. This is followed by April and November having 19 (16.8) occurrences each. Birds/wildlife strikes are least experienced in the months of August and September with two (1.8%) reported strikes each.

Table 1: Reported incidents of Bird Strike at MMIA (2004-2014)

Months	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total	%
Jan	1	0	0	0	0	1	0	0	0	3	2	7	6.2
Feb	0	1	0	0	0	0	1	0	1	0	2	5	4.4
Mar	2	2	3	0	0	0	8	0	3	3	1	22	19.5
Apr	3	0	0	4	0	3	2	0	4	1	2	19	16.8
May	1	1	0	2	0	2	2	0	0	1	0	9	8.0
Jun	0	0	0	0	0	0	0	0	4	0	0	4	3.5
Jul	0	0	0	0	1	0	0	0	1	2	0	4	3.5
Aug	0	0	0	0	0	2	0	0	0	0	0	2	1.8
Sept	0	0	1	0	0	1	0	0	0	0	0	2	1.8
Oct	0	0	1	0	1	3	0	1	0	2	0	8	7.1
Nov	0	0	1	1	1	6	1	2	4	3	0	19	16.8
Dec	0	2	1	0	0	2	0	3	1	2	0	11	9.7
Not Specified	0	0	0	0	0	1	0	0	0	0	0	1	0.9
Total	7	6	7	7	3	21	14	6	18	17	7	113	100
%	6.2	5.3	6.2	6.2	2.7	18.6	12.4	5.3	15.9	15.0	6.2	100	

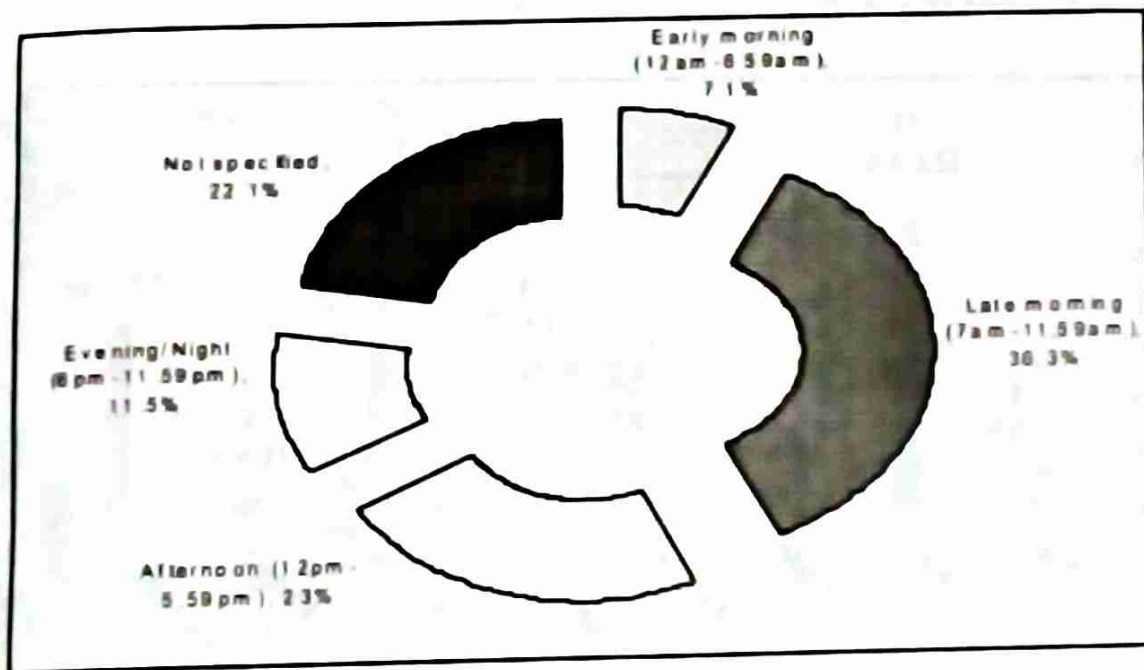
Source NCAA (2016)

It is very likely that before 2009 only a small proportion of the actual strike cases were being reported due to poor reporting, which may account for the few number of cases recorded. It is known that some strike incidents are unreported even now that there are improvements in reporting procedure and strike monitoring. It could also be deduced from the result that most cases of strikes are recorded during months associated with change in season from dry to rainy season and vice versa. These are the periods of seasonal migration of birds in the country and it should be expected that there will be increased risk of collision with aircraft at such periods. This is in line with the observation of Usman *et al.* (2012) that higher cases of bird strikes occur in

Nigeria at periods of change from one season to another.

4.1 Periods of Bird Strike Incidents

There is virtually no period of the day at which bird strikes have not occurred as recorded by NCAA but, strikes are observed to be more prevalent at some particular periods than others. The reported strikes were found to be more rampant in the late morning hours from 7am-11:59am when 36.3% of the total strikes occurred (Figure 2).



Source: NCAA(2016)

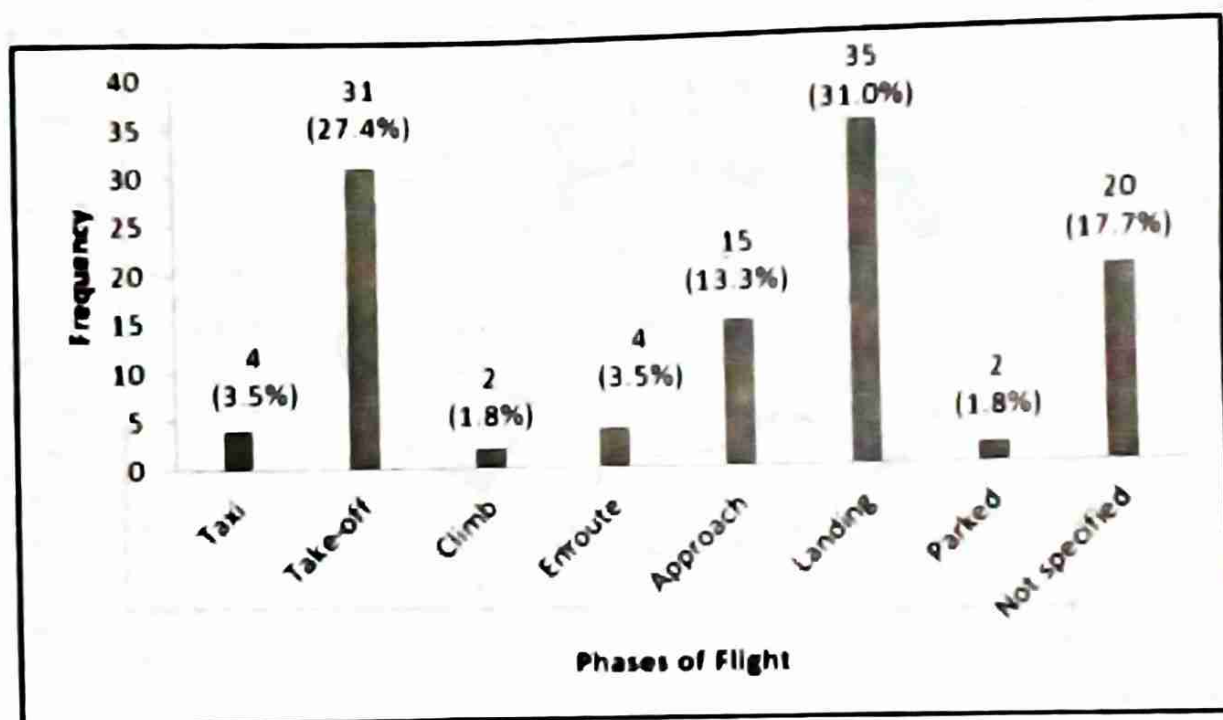
Figure 2: Period of Bird Strike Incidents at MMIA

Figure 2 further shows that a high proportion (23.0%) of the strikes also occurred during the afternoon (12pm-6:59pm). This is in line with the findings of US Federal Aviation Administration (US FAA) (2015) that most strikes involving civil aircraft occur during the day. However, results further indicate that for a large proportion (22.1%) of the strikes the period of occurrence could not be determined and were logged as "not specified". At times it becomes difficult to determine the actual period that a strike happened because the flight crew may not be aware of the strike, until the dent or damage to aircraft is discovered by ground crew during maintenance operations. Meanwhile, the reason for higher occurrence of strikes in the daytime can be attributed to the fact that most birds are more active during the daytime when they move around in search of food. However nocturnal birds and other animals are also attracted to airports at night, particularly because airports are usually lighted up by runway lights and illuminations

on airport infrastructure. Insects attracted by the lighting constitute great attraction to birds like owl and bats and small mammals that feed on them.

4.3. The Phases of Flight at which Strike incidents occurred

Bird strikes happened at all the six phases of flight but, at different frequencies of occurrence. The highest number of strikes (35) constituting 31% of all reported strikes from 2004 to 2014 occurred in the landing phase. This is followed by the take-off phase with 27.4% of the strikes. The lowest strikes incidents were recorded at the Enroute and Taxiing phases with 3.5% of the strikes each (Figure 3).



Source: Computed from field data (2016)

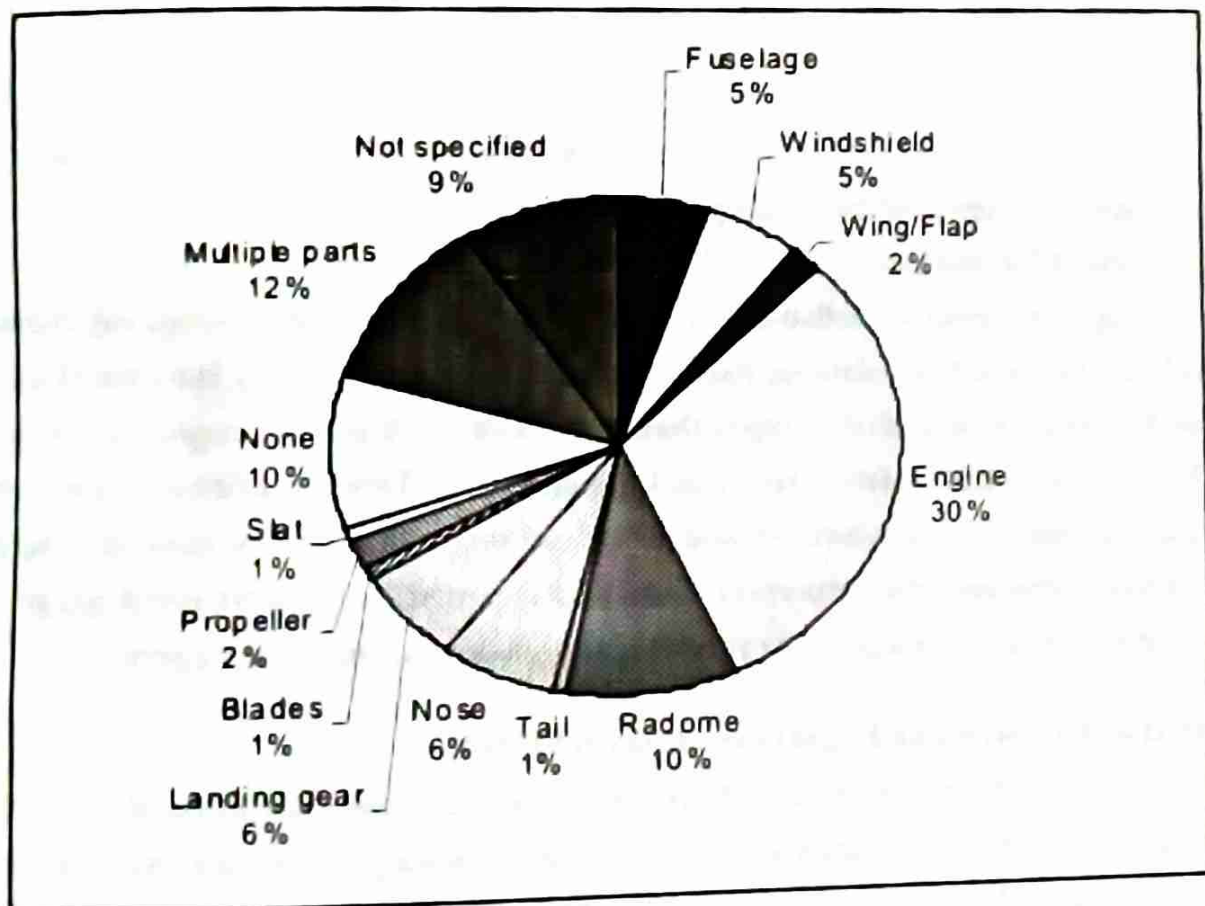
Figure 3: Phases of Flight and Bird strike incidence

The results as seen in Figure 3 is in line with findings in various parts of the world as observed by [International Bird Strike Committee (IBSC) (2006) and Shekhar (2014) that most bird strikes occur at approach, landing, take-off and climb phases which are phases when an aircraft is close to the ground. Fewer strike cases are recorded at enroute phase in particular because few birds fly at high altitudes associated with this phase. Also, it is common to have fewer strike incidents at the taxiing phase because, at this phase the aircraft has already landed and is only moving slowly to the parking area of the tarmac.

4.4. Parts of Aircraft Struck

The results show that aircraft engines are struck by birds most (31%) of the time as seen in Figure 4. This is followed by situations when multiple parts of the aircraft are hit in the same incident constituting 11.5%. Multiple hits usually occur when an aircraft flies into a flock of

birds and many parts of the aircrafts are struck at the same time, particularly common during seasonal migration of birds. The least struck parts are the tail and blades taking only 0.9% each of the total strikes while the wing/flap and propeller also suffer few hits (1.8% each). In addition, 9.7% of strikes were reported without direct collision with any part of aircraft. This is not surprising because, at times birds hovering very close to the aircraft may be thrown off to the ground by the force of the aircraft. Furthermore, it is not at all the time that strikes occur that the aircraft parts involved can be identified. Collision may be reported by people on the ground and the observation may even be supported by physical evidence of bird's carcass on the airfield but without physical evidence on the aircraft. At times, strikes happen even when aircrafts are parked leaving only the carcass of the bird on the airfield.

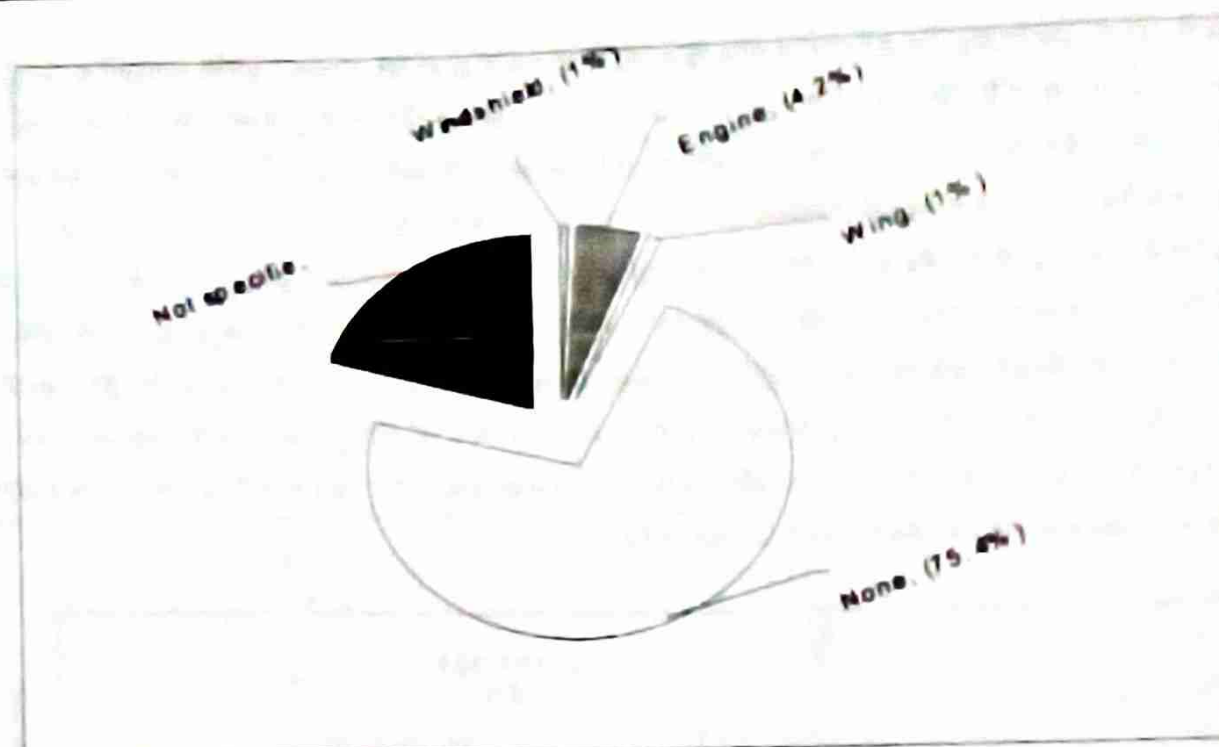


Source: NCAA (2016)

Figure 4: Parts of Aircraft Struck

4.5. Parts of Aircraft Damaged by Strikes

Results show that not all the reported bird strikes at MMIA resulted in damage to aircraft. Figure 5 indicates that 75.4% of the strikes did not result in any damage to aircraft. In addition, in 18.4% of the strike incidents, the parts damaged were not specified while the windshield and wings suffered the least damages (1% each).



Source: Computed from field data (2016)

Figure 5: Parts of Aircraft Damaged

Though, the result show that most of these strike incidents did not cause any damage to aircraft, those that resulted in damage must have cost the aviation industry hundreds of millions of Naira. For instance, as at 2010 to repair the engine fan blade for some category of aircraft cost about US\$18,750 to US\$25,000 (Dukiya and Ahmad, 2014). This is in addition to flight delays and cancellations and the potential danger of air crash that strikes portend. Therefore, irrespective of how small the proportion of strikes that caused damages to aircraft, it is pertinent to note that bird/wildlife strikes can be very dangerous to aircraft and air travellers.

4.6. Effect of Bird Strike on Flight Operations at MMIA

The effects that bird strike could have on flight operations were also examined. As seen in Table 2, the possible effects are aborted take-off, precautionary landing, air return, flight delay and aborted flight. However, as high as 82.3% of the reported strikes incidents at MMIA were found to have no effect on flight operations. On the other hand, some (9.7%) of the strike incidents resulted in aborted take-off, while 1.8% resulted in aborted flight. Although, it is difficult to accurately quantify the effect of bird strikes on flight operations monetarily, aborted flights (cancellation of flight) and air return in particular result in great financial burden to airline operators and passengers and great inconveniences to air travellers.

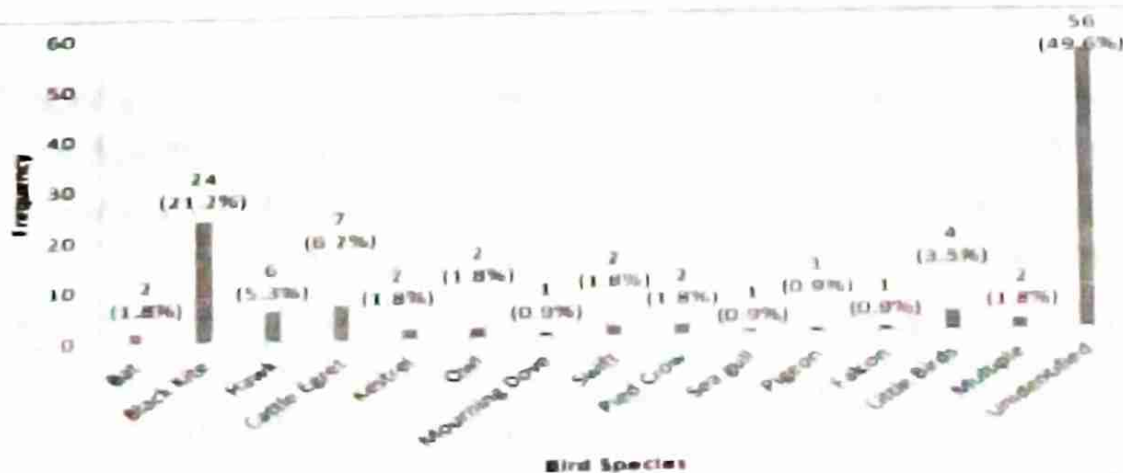
Table 2: Effects of Bird Strike on Flight Operations at MMIA

Effects on Flight	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total	%
Aborted Take off	0	1	2	1	1	1	0	0	2	3	0	11	9.7
Precautionary Landing	0	0	1	0	0	0	1	0	0	1	0	4	3.5
Air Return	0	0	0	0	0	0	0	0	0	0	0	1	0.9
Flight Delay	0	0	0	0	0	0	0	0	1	1	0	2	1.8
Aborted Flight	0	0	0	0	0	0	1	0	0	0	1	2	1.8
No effect	7	5	4	5	2	20	12	6	14	12	6	93	82.3
Total	7	6	7	7	3	21	14	6	18	17	7	113	100

Source: NCAA (2016)

4.7. Bird Species Involved in strikes at MMIA

Various species of birds were reported to be responsible for the strikes at MMIA from 2004-2014. No land animals were involved in collision with aircraft at the airport within the period. The birds involved are of various sizes and weight and they are; bat (*Corynorhinus townsendii*), black kite (*Milvus migrans*), hawk (*Accipiter striatus*), cattle egret (*Bubulcus ibis*), kestrel (*Falco tinnunculus*), owl (*Athene noctua*), mourning dove (*Zenaida macroura*), swift (*Apus apus*), pied crow (*Corvus albus*), seagull (*Larus dominicanus*), pigeon (*Columba livia*), falcon (*Falco berigora*) and several unidentified birds. However, of all the species of birds responsible for these strikes, black kite was observed to be the most prominent, being responsible for 21.2% of the strikes at the airport (Figure 6).



Source: Computed from NCAA (2016)

Figure 6: Species of Birds involved in strikes

Figure 6 further shows that a large proportion (49.6%) of the birds were unidentified. The least prominent bird species are falcon, pigeon, seagull, and mourning dove. Each being responsible for 0.9% involvement in all the strike incidents from 2004-2014. Inability to identify the species of birds involved in most of the strikes has serious negative implications for bird control. It means that the control of strikes will be more difficult and most probably ineffective. For effective control, the approach used normally vary from one specie to another therefore, proper identification of bird species is very important for developing adequate bird strike management programme for any airport.

4.8. Bird Strike Management Measures at MMIA

Various forms of equipment and control measures are used to manage the menace of bird strikes at MMIA. Wildlife Hazard Control Unit of Federal Airports Authority of Nigeria (FAAN) is responsible for bird strike control at the airport. Most importantly sanitation is made mandatory at the airport not only to maintain the aesthetics but also to mitigate bird strike threat. There are two main groups of measures used in combating bird strike at the airport as in other parts of the world. These are classified into proactive and reactive measures using both lethal and non-lethal approaches. The pro-active measures used are habitat management and exclusion techniques.

The habitat management techniques used involve non-lethal proactive measures consisting of basic habitat management practices. Measures such as keeping the grasses at appropriate height (long grass policy) as well as grade improvement within the airport are employed at the airport. Very short grasses are avoided because they allow small birds to have view over wider spaces and are able to detect danger from afar, while also exposing the soil surface. This makes it difficult for the birds to easily identify worms and insects on the ground from afar. Grasses are maintained at a height of about 150 to 200mm. The Grade improvement involves covering up all marshy areas with cut grasses to prevent pools for birds to perch for drinking.

The major exclusion method practiced at MMIA is perimeter fencing which helps to exclude bird from the airfield. This is another proactive non-lethal approach used at the airport. Other minor exclusion methods used include covering ditches, ponds, and drainages with nets and use of anti-perching spikes on sign posts and airport equipment.

A very important proactive measure at the airport involves the use of repellents such as methyl anthranilate and Anthraquinone. This is a non-lethal measure involving the use of non-toxic chemicals to disperse birds when sprayed where the birds usually congregate.

Pyrotechnics are also commonly used at MMIA. These include bangers and scarers, and gas cannon timers. The bangers are employed to disperse birds around the airfield before take-off

or arrival of aircrafts. The bangers produce scary sounds to chase away birds. The gas canons also perform the same purpose but produce greater degree of dispersal sound than the bangers. The gas canons are placed on the strip of the runway away from the shoulders and are employed before take-off or before landing to disperse birds within the movement area.

Trapping and relocation of birds are also employed at MMIA. Specifically this method involves the use of baits to trap birds that encroach on the airfield. These animals are then relocated to where they won't be a threat any longer.

Immediate removal of dead birds' remains is a reactive measure also used at the airport. This involves the removal of birds' carcasses after a strike has occurred so that it doesn't attract other species like hawks and vulture that feed on carcasses. The carcasses are preserved through refrigeration to allow further examination/analysis and to avoid dumping them around.

5. CONCLUSION AND RECOMMENDATIONS

No doubt, bird strike is a serious problem at Murtala Muhammed International Airport with serious negative economic and safety implications. The presence of garbage dumps, open drainage and mashes within the vicinity of the airport attracts bird and other animals. In addition, while reporting of strikes seems to have improved in recent years, poor identification of bird species involved remains a severe obstacle to effective strike control at the airport. This is because inability to properly identify problem birds makes it very difficult to employ appropriate control measures.

Airport authorities in the country should embark on programmes that will make airport vicinity less attractive to birds and other wildlife. This may involve habitat modification resulting in changing the floral setting of the airport premises. The environmental situation of individual airfields must be put into consideration in developing suitable habitat management programme for each area.

There is the urgent need to install Bird Strike Avoidance Radar and other modern equipments at all airports in the country to improve bird strike control. Installation of equipments like the Merlin Aircraft Avoidance Radar and Phoenix Bird Deterrent Systems will help to reduce strike occurrences.

Birds control officials should be properly trained and well equipped to modern standards. Modern training and retraining programmes must be developed to bring control officials abreast with modern control knowledge.

Methods of identification of bird species involved in strike should be improved on. Modern forensic technology should be adopted for analysing birds' remains as practiced in

the advanced countries. This will go a long way in helping to evolve adequate control measures at airports in the country.

Generality of the populace should be sensitized about birds' strikes most especially those living around airports. This will make people conscious of how their actions might attract birds to the area. People should be educated to avoid activities like indiscriminate dumping of refuse and improper sewage management that attract birds to the airport vicinity.

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