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Effect of Some Weather Variables on Flight Operations at Malam Aminu Kano International Airport, Kano State, Nigeria

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Abstract: *Weather hazards pose critical challenges to flight operations, leading to substantial disruptions, safety risks, and significant economic losses in the aviation industry. This study investigates the effects of selected aviation weather hazards (dust haze, thunderstorms, and rainfall) on flight operations at Malam Aminu Kano International Airport (MAKIA) over 30 years (1993 to 2023). By utilizing climatic data sourced from the Nigerian Meteorological Agency (NiMet) and the National Aeronautics and Space Administration (NASA) from 1993 to 2023 as well as flight operations data sourced from the Federal Airports Authority of Nigeria (FAAN) from 2013 to 2023, the research employed descriptive statistics and multiple linear regression analysis to uncover relationships between weather variables and flight disruptions. The findings reveal that dust haze accounts for 57% of flight delays and 51% of cancellations, while thunderstorms and rainfall contribute 27% and 16% to delays and 27% and 22% to cancellations, respectively. Correlation analyses further show a moderate relationship between dust haze occurrences and both flight delays and cancellations, with R-squared values of 0.543 and 0.1667, respectively. Conversely, thunderstorms showed weak correlations with flight delays and cancellations, with R-squared values of 0.0608 and 0.0217. Rainfall demonstrated negligible predictive value for flight delays (R-squared = 0.0004) and a modest correlation with cancellations (R-squared = 0.1633). Overall, weather hazards account for 21% of flight delays and 28% of cancellations, emphasizing significant vulnerabilities within aviation operations. The study underscores the necessity for enhanced meteorological forecasting and proactive management strategies to mitigate adverse weather impacts on flight safety and efficiency. Recommendations include redesigning flight schedules to accommodate seasonal weather patterns and improving communication of weather alerts. This research contributes valuable insights to the understanding of aviation operations in tropical climates and emphasizes the importance of integrating weather risk assessments within the broader context of aviation safety management.*

Keywords: *Weather, Hazards, Flight, Operations, Impact, Dust Haze, Rainfall, Thunderstorm*

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Nomenclature

Abbreviation	Expansion
IATA	InternationalAir Transport Association
ATC	Air Traffic Control
MAKIA	Malam Aminu Kano International Airport
LLWSAS	Low-Level Wind Shear Alert System
MSG	Meteorological Satellite Ground Station
NDB	Non-Directional Beacon
ILS	Instrument Landing System
NASA	National Aeronautics and SpaceAdministration
FAAN	Federal Airports Authority of Nigeria

1. Introduction

The aviation industry is a cornerstone of global transportation, facilitating both domestic and international travel, trade, and economic growth [2] [15][16][3]. However, this industry is highly susceptible to the adverse impacts of weather hazards, which can disrupt flight operations, compromise passenger safety, and result in significant economic losses [8][7]. Among the most critical challenges faced by aviation operators worldwide are the impacts of tropical aviationweather hazards [20] [5]. Tropical regions, including areas such as Malam Aminu Kano International Airport in Kano, Nigeria, are particularly prone to a wide range of aviation weather hazards. These hazards include thunderstorms, dust haze, wind shear, turbulence, and other meteorological phenomena that can lead to various operational disruptions. For instance, thunderstorms can produce severe turbulence, lightning, and strong winds, posing risks to both ground and in-flight operations. Dust haze and low visibility conditionscan impede takeoffs, landings, and ground movements, often leading to delays and diversions. Wind shear, characterized by sudden and unpredictable changes in wind speed and direction, presents a significant challenge during the takeoff and landing phases of flights [13].

The importance of weather conditions in aviation cannot be overstated. Numerous studies have documented the detrimental impacts of weather on aviation. According to [17],adverse weather conditions such as thunderstorms and low visibility from phenomena like fog anddust haze significantly increase the likelihood of flight delays and cancellations. The

IATA (2022) reported that approximately 71% of air accidents in Nigeria are attributed to poor weather conditions. Various researchers, including [19] and [1], have noted a steady rise in recorded cases of flight disruptions due directly to weather-related factors, emphasizing the need for a deeper understanding of how thesehazards affect flight efficiency. The author [19] noted that weather affects all aspects of aerodrome operations, including aircraft fuelling, cleaning, baggage handling, catering, maintenance, and flight scheduling and as such, poor weather can notably reduce the functioning capacity of airports and even entire airspace regions, leading to delays, diversions, and cancellations. Despite Nigeria'srelatively conducive weather, there has been a steady increase in recorded flight delays, diversions,and cancellations, largely due to poor weather conditions [21]. The Nigerian aviation industry witnessed its darkest period between 2003 and 2010 when several aircraft accidents occurred, resulting in significant loss of life. Investigations revealed that many of thesecrashes were traceable to bad weather and wind shear, compounded by pilot error and mechanical failure [12] [11]. For example, the Sosoliso Airlines Flight 1145 crash in 2005, which resulted in 108 fatalities, was attributed to weather-related factors (Ministryof Aviation, 2006).

Recent studies have emphasized the critical role of accurate weather forecasting and proactive measures in mitigating weather-related disruptions in aviation [6] [10]. The integration of modern avionics and automated ground instrumentation has improved decision-making processes, yet weather remains a vital factor in aircraft operations. National weather services and ATC staff are responsible for providing up-to-date weather information to ensure safe and efficient flight operations [6]. Despite advancements, the Nigerian aviation industry continues to grapple with weather-induced disruptions. Weather phenomena such as thunderstorms, fog, harmattan dust haze, and wind shear are prevalent during different seasons, posing substantial risks to flight safety and efficiency [21]. Poor visibility, in particular, remains a significant challenge, leading to frequent delays and cancellations [4][18]. Moreover, earlier studies primarily addressed individual weather hazards rather than their cumulative effect on operational disruptions. The need for comprehensive analysis that encompasses multiple weather factors is crucial, especiallyconsidering the dynamic interactions among dust haze, thunderstorms, and rainfall in tropical environments where the interplay of these variables can exacerbate their effects on flight operations.

Therefore, this study aims to investigate the effects of selected aviation weather hazards on flightoperations at Malam Aminu Kano International Airport, Kano, focusing on dust haze, thunderstorms, and rainfall. The research will analyze weather data and flight operation records to quantify the impact of these hazards and propose mitigation strategies to enhance aviation safety and efficiency.

2. Study Area

MAKIA is strategically located in Kano, Nigeria, and serves as a significant hub for both domestic and international air traffic. The airport is situated at approximately latitude 12°02'55"N and longitude 8°31'20"E with an elevation of 1562 feet (476 meters) above sea level. The climatic conditions of the Kano region are classified as Tropical wet and dry (Aw) according to Köppen's climate classification. This classification indicates a distinct wet and dry season, each bringing different weather challenges to aviation operations. MAKIA boasts of two runways, one designated for civil aviation and the other for military use. The airport is equipped with various facilities essential for safe and efficient operations, including a control tower, catering services, firefighting trucks, and advanced meteorological equipment provided by the Nigerian Meteorological Agency (NiMet). Key meteorological instruments and systems at theairport include the LLWAS, MSG, airport radar approach, runway lights, NDB, VHF Omnidirectional Range (VOR), and ILS.

The unique geographical and climatic conditions of the Kano region, coupled with the airport's infrastructure, make it an important case study for understanding the impact of weather hazards onaviation operations. The airport's location within the tropics subjects it to weather phenomena such as dust haze, thunderstorms, and heavy rainfall, which can significantly disrupt flight schedules and operations. Fig. 1 depicts the location of MAKIA in Kano state showing its runway, administrative building, and airport boundary.

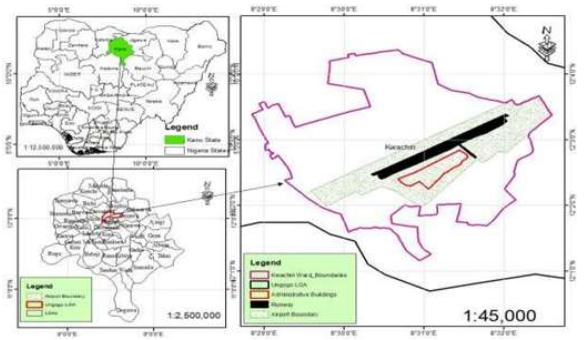


Fig. 1. Mallam Aminu Kano International Airport, Kano Source: Geography Department, FUT Minna (2024)

3. Materials and Methods

This research employs a systematic approach to investigate the effects of selected aviation weather hazards (dust haze, thunderstorms, and rainfall) on flight operations at MAKIA. The methodology encompasses the study design, data collection, and analytical techniques.

3.1 Study Design

The study adopts a cross-sectional design, whereby data on weather hazards were collected over 30 years (1993 to 2023) and data on flight operations were collected over 10 years (2013 to 2023). These periods provide a comprehensive temporal context to analyze trends in weather occurrences and their corresponding impacts on flight operations.

3.2 Data Collection

Two primary types of data were utilized for this study: meteorological data and flight operationaldata.

3.2.1 Meteorological Data

Meteorological data encompassing occurrences of dust haze, thunderstorms, and rainfall were sourced from:

i. **Nigerian Meteorological Agency (NiMet)**: Historical weather data on rainfall, dust haze, and thunderstorm occurrences over MAKIA from 1993 to 2023 were retrieved from the NiMet archives.
ii. **NASA Prediction of Worldwide Energy Resources (POWER) datasets**: Complementary high-quality rainfall data over MAKIA from 1993 to 2023 was accessed to provide broader perspectives on climate trends from NASA.

3.2.2 Flight Operation Data

Operational data concerning flight delays and cancellations from 2013 to 2023 were obtained fromthe FAAN. This archival data is authoritative for assessing flight performance metrics concerning weather hazards.

3.3 Data Analysis Techniques

The data analysis phase incorporates both descriptive and inferential statistical methods to derivemeaningful interpretations from the collected data.

3.3.1 Descriptive statistics

Summary statistics, such as mean, median, frequency, and standard deviation were calculated for each weather parameter (dust haze, thunderstorms, and rainfall) as well as flight operation metrics(delays and cancellations). This provided insights into central tendencies and variations within thedata set over the study period.

3.3.2 Time-Series Analysis

Time-series analysis techniques were applied to identify trends, seasonality, and long-term patternsin weather hazards and flight operations.

3.3.3 Inferential Statistics

Correlation and regression analyses were utilized to quantify the relationships between weather hazards and flight operations.

i. **Correlation analysis**: This assessed the statistical relationships between weather occurrences and flight disruptions.
ii. **Multiple linear regression analysis:** A regression model was developed to quantify the impact of weather hazards on flight delays and cancellations. The model is expressed as follows:

$$Y = a + bX \tag{1}$$

$$b = \frac{\left(N\sum XY - \left(\sum X\right)\left(\sum Y\right)\right)}{\left(N\sum X^2 - \left(\sum X\right)^2\right)} \tag{2}$$

$$a = \frac{\left[\sum Y - b\left(\sum X\right)\right]}{N} \tag{3}$$

Where: X is the independent variable (weather hazards), Y is the dependent variable (flight operations), b is the slope of the regression line, a is the intercept point of the regression line and the y-axis, N is the number of values or elements and y is the second score. $\sum XY$ is the sum ofthe product of the first and second scores, $\sum X$ is the sum of the first scores, $\sum Y$ is the sum of the second scores and $\sum X^2$ is the sum of the squares of the first squares.

Data visualization included graphs and charts such as line plots, histograms, bar charts, scatter plots, and pie charts to illustrate trends, variations, and relationships over time. This facilitated the communication of findings and supported the development of recommendations for mitigating the impact of weather hazards on flight operations at MAKIA.

4. Results and Discussion

4.1 Distribution of Dust Haze, Thunderstorms, and Rainfall over MAKIA

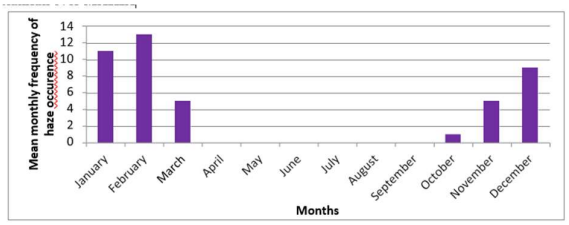


Fig. 2. Mean Monthly Frequency of Dust Haze Occurrence over MAKIA
Source: Author (2024)

The mean monthly frequency of dust haze occurrences illustrated in Fig. 2 highlights a strong seasonal component. High frequencies in January, February, March, and December correspond with the dry season, while minimal occurrences from May to September coincide with the wet season. This seasonal variation aligns with the climatic patterns of the region, where precipitationduring the wet season reduces dust haze.

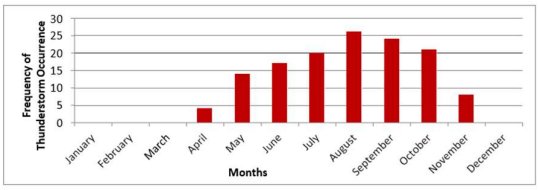


Fig. 3. Mean Monthly distribution of Thunderstorm over MAKIA
Source: Author (2024)

Fig. 3 indicates that thunderstorms are most frequent from May to October, ranging between 10.45% to 15.67% of the total annual occurrences. This period aligns with the rainy season in northern Nigeria, where increased atmospheric instability leads to frequent thunderstorms. Minimal occurrences from December to April reflect the dry season, underscoring the seasonal nature of thunderstorms in the region.

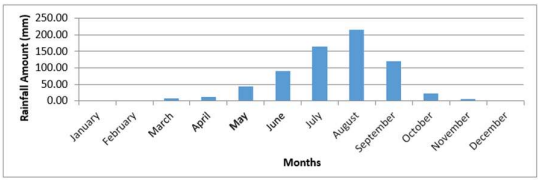


Fig 4. Mean Monthly Rainfall Distribution Over Kano Airport
Source: Author (2024)

Fig. 4 illustrates the mean monthly rainfall distribution with negligible rainfall from January to April and November to December. Rainfall begins to increase in April, peaking from July to September, with August recording the highest at approximately 215 mm. This clear distinction between dry and rainy seasons is typical for the region, where the onset and cessation of the rainyseason are well-defined.

4.2 Relationship between Weather Hazards and Flight Operations at MAKIA

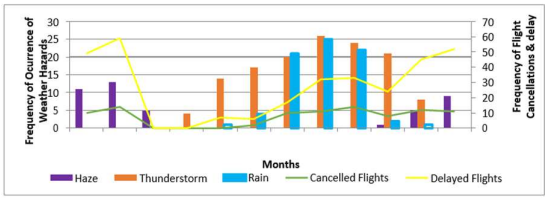


Fig. 5. Mean Monthly Weather Conditions and their Impact on Flight Operations in MAKIA (2003 – 2023)
Source: Author (2024)

Fig. 5 shows a clear seasonal trend in weather hazards impacting flight operations. Dust haze ismore frequent in cooler months (January, February, November, and December), while thunderstorms peak during the summer months (June to August), and rainfall is most prevalent from June to September. The correlation between these hazards and flight disruptions is evident, with high frequencies of thunderstorms and rainfall corresponding to increased flight cancellations and delays.

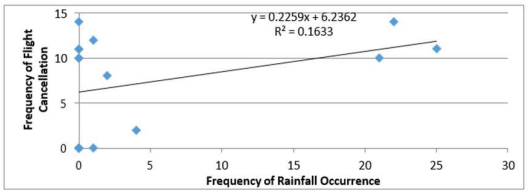


Fig. 6. Correlation between Rainfall Occurrence and Flight Cancellation in MAKIA
Source: Author (2024)

Fig. 6 illustrates the correlation between rainfall occurrences and flight cancellations at MAKIA. The R-squared value of 0.1633 indicates that approximately 16.33% of the variability in flight cancellations can be explained by the frequency of rainfall occurrence. While there is a positive correlation—suggesting that increased rainfall tends to result in more flight cancellations—the relatively low R-squared value implies that otherfactors also significantly contribute to flight cancellations. These could include operational inefficiencies, technical issues, and human factors.

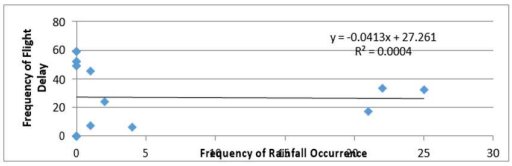


Fig. 7. Correlation between Rainfall Occurrence and Flight Delay in MAKIA
Source: Author (2024)

Fig. 7 shows the correlation between rainfall occurrences and flight delays at MAKIA. The R-

squared value of 0.0004 indicates a negligible correlation, with only 0.04% of the variability in flight delays being explained by rainfall frequency. This suggests that rainfall alone is not a significant predictor of flight delays. The data imply that factors other than rainfall, such as operational constraints and scheduling issues, are more critical in causing flight delays.

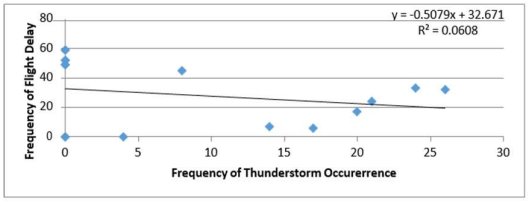


Fig. 8. Correlation between Thunderstorm Occurrence and Flight Delay in MAKIA
Source: Author (2024)

Fig. 8 presents the correlation between thunderstorm occurrences and flight delays at MAKIA. The R-squared value of 0.0608 indicates that only 6.08% of the variability in flight delays can be explained by the frequency of thunderstorms. The negative slope suggests that as the frequency of thunderstorms increases, the frequency of flight delays slightly decreases, which is counterintuitive. This weak correlation implies that thunderstorms are not a major predictor of flight delays at MAKIA. Effective management and mitigation strategies during thunderstorms might be the reason for their low impact on flight delays.

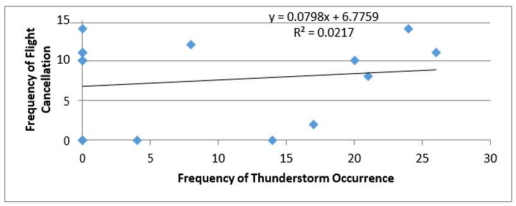


Fig. 9. Correlation between Thunderstorm Occurrence and Flight Cancellation in MAKIA
Source: Author (2024)

Fig. 9 depicts the correlation between thunderstorm occurrences and flight cancellations at MAKIA. The R-squared value of 0.0217 indicates that only 2.17% of the variability in flight cancellations can be explained by the frequency of thunderstorms. This very low correlation suggests that thunderstorms are not a significant factor in flight cancellations. Similar to delays, this could be due to effective management practices mitigating the impact of thunderstorms on flight operations.

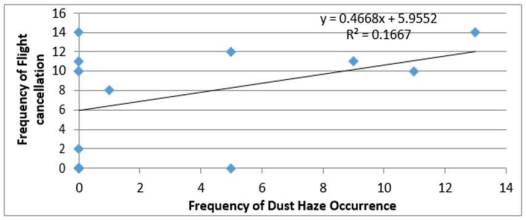


Fig. 10. Correlation between Dust Haze Occurrence and Flight Cancellation in MAKIA
Source: Author (2024)

Fig. 10 shows the correlation between dust haze occurrences and flight cancellations at MAKIA. The positive slope indicates that as the frequency of dust haze occurrences increases, the frequency of flight cancellations also tends to increase. The R-squared value of 0.1667 suggests that about 16.67% of the variability in flight cancellations can be explained by the frequency of dust haze occurrences. This moderate correlation highlights dust haze as a more significant predictor of flight cancellations compared to other weather phenomena. The impact of reduced visibility due to dust haze is likely a critical factor in these cancellations.

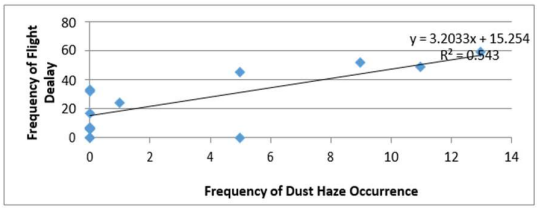


Fig. 11. Correlation between Dust Haze Occurrence and Flight Delay in MAKIA
Source: Author (2024)

Fig. 11 illustrates the correlation between dust haze occurrences and flight delays at MAKIA. The positive correlation indicates that as the frequency of dust haze occurrences increases, the frequency of flight delays also tends to increase. The R-squared value of 0.543 shows a moderatelevel of correlation, suggesting that dust haze occurrences explain a significant portion of flight delays. This finding underscores the substantial impact of dust haze on flight operations, where poor visibility conditions likely lead to operational delays.

4.3 Distribution of Flight Delays and Cancellations in MAKIA

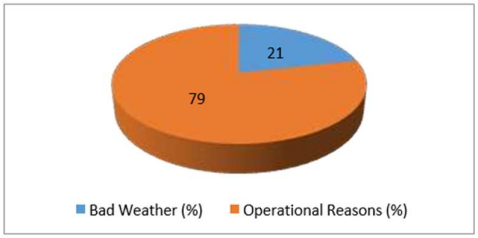


Fig. 12. Annual Distribution of Flight Delay in MAKIA
Source: Author (2024)

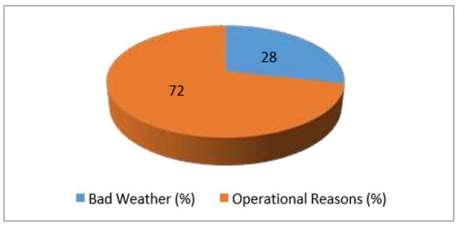


Fig. 13. Annual Distribution of Flight Cancellation in MAKIA
Source: Author (2024)

Fig. 12 reveals that 79% of flight delays are due to operational reasons, while weather accountsfor 21%. Similarly, Fig. 13 shows that 72% of flight cancellations are operational, with weathercontributing 28%. These figures highlight that while weather significantly impacts flight operations, operational inefficiencies are the predominant cause of disruptions in MAKIA.

4.4 Distribution of Weather Hazards causing Flight Delays and Cancellations at MAKIA

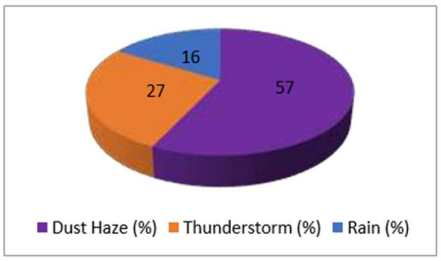


Fig. 14. Distribution of Weather Hazards Contributing to Flight Delays at MAKIA
Source: Author (2024)

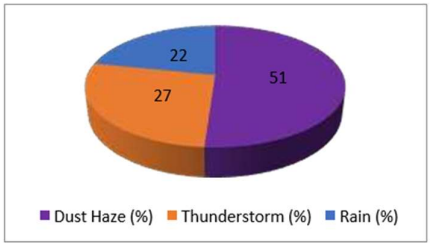


Fig. 15. Distribution of Weather Hazards Contributing to Flight Cancellations at MAKIA
Source: Author (2024)

Figures 14 and 15 illustrate that dust haze is the leading weather hazard, accounting for 57% of flight delays and 51% of cancellations. Thunderstorms cause 27% of delays and 27% of cancellations, while rain contributes 16% of delays and 22% of cancellations. These findings underscore the significant impact of dust haze and thunderstorms on flight operations at Kano Airport.

5. Conclusion and Recommendations

The findings from this study revealed that weather hazards significantly affect flight operations, with dust haze being the most impactful, followed by thunderstorms and rainfall. The data analysis showed that dust haze occurrences account for the highest proportion of flight delays (57%) and cancellations (51%). Thunderstorms contribute to 27% of delays and cancellations, while rainfallaccounts for 16% of delays and 22% of cancellations. Notably, weather-related factors are responsible for 21% of total delays and 28% of total cancellations while operational reasons constitute 79% of total delays and 72% of total cancellations. The correlation analysis further underscored that dust haze has a moderate but significant impact on flight operations, whereas thunderstorms and rainfall showed weaker correlations.

These results highlight the need for effective management and mitigation strategies to address weather-related disruptions in aviation. Despite the relatively conducive weather in Nigeria, the frequency of flight disruptions due to adverse weather conditions remains high, emphasizing the critical role of weather forecasting and proactive operational adjustments in ensuring aviation safety and efficiency. While weather factors play a considerable role in altering flight operations, it is essential to recognize that other variables, such as operational inefficiencies, human errors, and technical issues, also contribute to flight disruptions. Thus, a multifaceted approach isnecessary to enhance aviation safety and operational efficiency. Based on the findings of this study, the following recommendations are proposed to mitigate the impact of aviation weather hazards on flight operations at MAKIA:

i. Enhance the accuracy and timeliness of weather forecasts by upgrading meteorological tools and increasing the frequency of updates, ensuring all stakeholders receive real-time weather information to adjust flight operations accordingly.
ii. Modify flight schedules to avoid peak periods of severe weather conditions, such as scheduling more night flights during the harmattan season and prioritizing early morning flights during the rainy season to minimize disruptions.
iii. Regularly train pilots and air traffic controllers on weather-related procedures and decision-making, using simulations and updated standard operating procedures to effectively handle unexpected weather changes.
iv. Establish robust early warning systems to quickly disseminate weather alerts to all stakeholders, including airlines, ground staff, and passengers, allowing for better preparation and response to adverse conditions, thus reducing risks and operational disruptions.
v. The government should support the aviation industry by upgrading outdated equipment, funding

training programs, and enforcing strict compliance with international standards and recommended practices, ensuring the industry meets global trends in advancedtechnology and safety management.

6. References

[1] C. O. Akanni, A. M. Hassan, and T. C. Osuji, "Empirical analysis of extreme weather conditions and aviation safety in Nigeria", *Ethiopian Journal of Environmental Studies and Management*, Vol. *9*, Vol. 6, pp. 680-690, 2016.

[2] E. A. Akintade, S. O. Akande, M. O. Falabi, and O. O. Olawookeye – Ayodele, "Evaluationof Socio-Economic Benefits of Air Transport Industry in Nigeria", *Journal of Urban and Environmental Research (JUER),* Vol. 3, No. 1, ISSN: 2992 – 619X, 2023.

[3] F. O. Aiyegbajeje "Assessing the Determinants of Choice of Airline among Domestic Air Travelers in Lagos, Nigeria", *Ghana Journal of Geography*, Vol. 15, No. 1, pp. 130-155, 2023.

[4] J. F. Ayoade, "*Introduction to climatology for the tropics",* Ibadan: Spectrum Books Ltd, 2004.

[5] R. Burbidge, C. Paling, and R. M. Dunk, "Absystematic review of adaptation to climate change impacts in the aviation sector", *Transport Reviews,* Vol. 44, No. 1, 2024.

[6] F. Dalton, "Aviation Meteorology. *Journal of Navigation"*, Vol. 45, No. 2, 252-257, 1992.

[7] K. Dube, G. Nhamo, and D. Chikodzi, "COVID-19 pandemic and prospects for recovery of the global aviation industry", *Journal of Air Transport Management*, Vol. *92*, pp. 102022, 2021.

[8] M. K. Hosea, "Effect of Climate Change on Airline Flight Operations at Nnamdi Azikiwe International Airport, Abuja, Nigeria", *Science World Journal,* Vol. 14, No. 2), 2019.

[9] International Air Transport Association (IATA) (2022). *2021 Safety Report.* Edition 58, Montreal- Geneva.

[10] A. Klein, S. Kavoussi, and R. S. Lee, "*Weather forecast accuracy: study of the impact on airport capacity and estimation of avoidable costs"*, Paper presented to the eighth USA/Europe Air Traffic Management Research and Development Seminar, 2009.

[11] W. Knecht, "*Pilot willingness to take off into marginal weather, Part II: Antecedent overfitting with forward stepwise logistic regression",* (Technical Report DOT/FAA/AM- 05/15). Washington, DC: Federal Aviation Administration, Office of Aerospace Medicine, 2005.

[12] M. J. Koetse, and P. Rietveld, "The impact of climate change and weather on transport: An overview of empirical findings", *Transportation Research,* D14, 205–221, 2009.

[13] A. Kwasiborska, M. Grabowski, A. N. Sedláčková, and A. Novák, "The Influence of Visibility on the Opportunity to Perform Flight Operations with Various Categories of theInstrument Landing System", *Sensors*, Vol. *23*, No. 18, pp. 7953, 2022.

[14] Ministry of Aviation, Federal Republic of Nigeria, "*Civil Aviation Accident Report No. FMA/AIPB/424."* [Final Report on the Accident of Sosoliso Airlines DC9 – 32 Aircraft Registered 5N-BFD at Port Harcourt International Airport on 10th December 2005. 2006.

[15] A. E. Owoputi, "Examining Aviation Industry Development in Nigeria Economy," *Journalof Research in National Development (JORIND),* 13, No. 2, 2015.

[16] T. B. Pepinsky, and J. Pierskalla, "Bureaucracy and Service Delivery," *Social Science Research Network (SSRN) Electronic Journal*, Vol. 20, pp.1–20, 2016.

[17] M. Sasse, and T. Hauf, "A study of thunderstorm-induced delays at Frankfurt Airport, Germany," *Meteorological Applications*, Vol. 10, No. 1, pp. 21-30, 2003.

[18] W. Shadare, "Safety at the Airport," *Guardian Newspaper,* 2005.

[19] A. G. Spyrou, "*Global Climate Change and the Shipping Industry*," iUniverse, Inc. ISBN: 978-1-4502-4415-2, 2010.

[20] A. Voskaki, T. Budd, and K. Mason, "The impact of climate hazards to airport systems: a synthesis of the implications and risk mitigation trends," *Transport Reviews,* Vol. 43, No. 4, pp. 652 – 675, 2023. doi:

[21] V. E. Weli, and U. E. Ifediba, "Poor weather conditions and flight operations: Implications for air transport hazard management in Nigeria," *Ethiopian Journal of Environmental Studies and Management*, Vol. 7, No. 3, pp. 235-243, 2014.