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FACTORS INFLUENCING AIRCRAFT CRASHES IN THE AVIATION INDUSTRY: A CASE OF TANZANIA

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ABSTRACT

Aircraft crashes remain an aviation problem despite continued improvements in aircraft technology, training, maintenance, air traffic management, and safety systems. This study examined the influence of human, mechanical, and environmental factors on aircraft crash occurrence in Tanzania. Study it adopted a positivist philosophy, deductive approach, and descriptive research design. The target population consisted of 468 aviation professionals from selected airlines and aviation institutions. A sample of 216 was determined by using Yamane's formula. Structured questionnaires were administered to pilots, aircraft maintenance engineers, flight dispatchers, air traffic controllers, and accident investigation personnel. A total of 189 valid responses were obtained, yielding an 87.5% response rate. Data were analyzed using descriptive statistics, Pearson correlation, and multiple linear regression in SPSS. Results indicated positive significant associations between human factors ($r = .376$), mechanical factors ($r = .415$), environmental factors ($r = .439$), and aircraft crash occurrence (all $p < .001$). In the regression model, all predictors were statistically significant: human factors ($\beta = .287$, $p < .001$), mechanical factors ($\beta = .317$, $p < .001$), and environmental factors ($\beta = .351$, $p < .001$). The model summary reported $R^2 = .394$ and adjusted $R^2 = .382$. Environmental factors had the largest standardized coefficient, followed by mechanical and human factors. The study concludes that crash occurrence is associated with interacting human, mechanical, and environmental risk conditions. It recommends strengthening personnel training and fatigue controls, aircraft maintenance and inspection systems, weather and operational risk assessment, and integrated safety oversight.

Keywords: aircraft crashes; human factors; mechanical factors; environmental factors.

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1. Introduction

Aviation is a vital part of the global transportation system, enabling movement of passengers and freight while supporting tourism, trade, investment, and economic activity. Improvements in aircraft design, crew training, maintenance, air traffic management, and safety management systems have strengthened aviation safety over time. Nevertheless, accidents continue to occur and may lead to fatalities, injuries, aircraft and infrastructure damage, operational disruption, financial loss, and reduced public confidence. Accident prevention therefore remains a continuing priority for operators, regulators, aviation professionals, and international organizations (IATA, 2026).

Aviation safety performance is not necessarily linear. Annual accident counts fluctuate with the amount and type of aviation activity, operational exposure, geography, and the occurrence of individual events. Absolute accident numbers should therefore be interpreted alongside rates that account for flight or sector activity. IATA's historical reporting shows that accident occurrence has varied across years even as long term safety systems have developed. The persistence of accidents demonstrates that technological progress and regulatory standards must be complemented by effective human performance, aircraft reliability, operational risk management, and organizational safety practices. (IATA, 2023)

Africa has experienced continuing aviation accident challenges, including variations in operator safety performance and exposure to infrastructure, technical capacity, regulatory, and environmental constraints. The regional context underscores the need to examine aircraft accident within individual national aviation systems rather than assume that global patterns apply equally to every country. Tanzania's aviation system includes scheduled and charter operations, government aviation services, air traffic services, safety oversight, and operations serving geographically diverse destinations. These operations encounter varied terrain, weather, runway conditions, and levels of operational support (TCAA, 2025). This study consequently focuses on Tanzania and examines the influencing factors on aircraft crashes' occurrence in Tanzania.

1.1 Problem Statement

Aircraft crashes remain a problem concern even where improvements have been made in aircraft technology, crew training, maintenance, safety management, and regulatory oversight. International

safety reports continue to document accidents, fatalities, and regional differences in accident rates. Such evidence reinforces the importance of continuous safety improvement and of identifying risk factors that can be managed before they develop into accidents.

The research problem addressed in this study is the lack of empirical evidence concerning the influence of human, mechanical, and environmental factors on aircraft crash occurrence in Tanzania. The study sought to establish the direction and statistical significance of the relationships between these factors and crash occurrence, using responses from aviation professionals. Evidence from the study is intended to inform safety focused training, technical maintenance, environmental risk management, and oversight priorities.

1.2 Objectives

1.2.1 General Objective

To analyze the factors influencing aircraft crashes in the aviation industry, with a case of Tanzania.

1.2.2 Specific Objectives

i. To examine the influence of human factors on aircraft crashes in the aviation industry.
ii. To assess the influence of mechanical factors on aircraft crashes in the aviation industry.
iii. To analyze influence environmental factors on aircraft crashes in the aviation industry.

1.3 Significant

The study is significant for aviation operators because its findings help identify areas for operational safety attention and prioritize interventions. For aviation regulators, the results provide local evidence that may inform safety oversight, surveillance, and compliance monitoring. Aviation professionals may benefit from a clearer understanding of the risk dimensions assessed and the importance of coordination among flight crews, maintenance, dispatch, air traffic control, and accident investigation. The study also has wider economic and social relevance because safe and reliable air transport supports connectivity, tourism, trade, and passenger confidence. Finally, the study adds Tanzania focused empirical evidence to the aviation safety literature and may provide a foundation for future research using accident records, operational data, and more specialized safety indicators.

2. Literature Review

The literature review provides an overview of existing studies related to aircraft crashes and the factors contributing to aviation accidents globally, in Africa, and specifically in Tanzania. This

review helps to identify research gaps and contextualize the current study, which investigates factors contributing to aircraft crashes in the aviation industry, focusing on the Tanzania. The review is structured around human factors, mechanical factors and environmental factors.

2.1 Theoretical Framework

This study is guided by the Haddon Matrix Model, developed by William Haddon Jr. as an analytical framework for understanding the causes and prevention of accident producing events. The model provides a systematic way of examining accidents by considering factors related to the human, vehicle or equipment, and physical and social environment across three stages: pre-event, event, and post-event (Haddon, 1970; Haddon, 1980). The pre-event stage considers conditions that exist before an accident occurs, the event stage focuses on factors operating during the accident, while the post-event stage considers factors that influence the consequences and outcomes following the accident. The model is particularly useful because it views accidents as the result of interactions among several factors rather than attributing them to a single cause.

In this study, the Haddon Matrix Model is applied to examine the different circumstances that may contribute to aircraft crashes. Human related conditions such as pilot error, fatigue, poor decision making, and communication breakdown may exist before or during a flight and can affect the likelihood of an accident. Similarly, mechanical conditions, including maintenance failures, engine malfunctions, and aging aircraft, represent vehicle related factors that may contribute to an accident. Environmental conditions such as adverse weather, poor visibility, and turbulence may also interact with human and mechanical factors to increase aviation risks. Therefore, the model provides a useful basis for examining the interaction between the human, aircraft, and environmental dimensions of aircraft.

One major strength of the Haddon Matrix Model is its comprehensive and systematic approach to accident analysis. Instead of focusing only on the immediate cause of an accident, the model encourages researchers to consider several contributing factors before, during, and after the event (Haddon, 1970). This makes it useful for identifying areas where preventive measures can be introduced. Another strength is its flexibility, as the model can be applied to different types of

injury producing events and adapted to specific sectors such as transport and aviation. In this study, its multidimensional approach helps organize the investigation of human, mechanical, and environmental factors associated with aircraft crashes in Tanzania.

Generally, the Haddon Matrix Model is considered appropriate for this study because it provides a structured basis for examining aircraft crashes from multiple dimensions. Its focus on human, vehicle, and environmental factors corresponds closely with the three independent variables examined in this study. The model therefore guides the study in identifying and analyzing the specific components of human factors, mechanical factors, and environmental factors that may influence aircraft crashes in the Tanzanian aviation industry.

2.2 Empirical Evidence

The empirical literature review examines previous evidence on factors contributing to aircraft crashes, focusing on human, mechanical, and environmental factors. Human factors include pilot error, fatigue, poor decision making, and communication breakdown; mechanical factors involve maintenance failures, engine malfunctions, and aging aircraft; while environmental factors include adverse weather, poor visibility, and turbulence. These factors are widely recognized in aviation research as contributing to accident risk (ICAO, 2023; IATA, 2026).

2.2.1 Human Factors and Aircraft Crashes

Previous studies identify human factors as major contributors to aviation accidents, particularly pilot error, fatigue, poor decision making, and communication breakdown. Pilot error may involve incorrect control inputs, procedural violations, or failure to respond appropriately to hazards. Fatigue can reduce alertness, concentration, and reaction time, while poor decision making may result in inappropriate responses to emergencies or changing flight conditions. Communication breakdown among pilots, air traffic controllers, and other operational personnel may lead to misunderstandings and delayed responses. (Wiegmann & Shappell 2017; ICAO,2023) emphasise the importance of human performance, crew coordination, communication, and adherence to procedures in aviation safety. In Tanzania, (TCAA, 2023) also identifies training, situational awareness, compliance with procedures, and crew resource management as important safety concerns. However, limited empirical evidence exists regarding the specific influence of these human factors on aircraft crashes in Tanzania, which this study seeks to investigate.

2.2.2 Mechanical Factors and Aircraft Crashes

Mechanical factors are associated with the technical condition, maintenance, and reliability of aircraft systems. Previous literature indicates that maintenance failures, engine malfunctions, and component deterioration can compromise aircraft airworthiness and operational safety. Inadequate inspection, improper repairs, and failure to identify technical defects may increase the risk of aircraft malfunction. Engine failure may affect aircraft performance and require immediate corrective action from the flight crew. Additionally, aging aircraft may experience component wear and deterioration if maintenance and inspection programmes are inadequate, although aircraft age alone does not necessarily indicate unsafe operation. (Stolzer et al. 2016; ICAO, 2023) emphasise the importance of maintenance systems, airworthiness, technical inspections, and safety management in preventing aviation accidents. (TCAA, 2023) also recognizes aircraft malfunction as a safety concern in Tanzania. Nevertheless, limited empirical research has examined how maintenance failures, engine malfunctions, and aging aircraft specifically influence crashes in the Tanzanian aviation industry.

2.2.3 Environmental Factors and Aircraft Crashes

Environmental factors influence aviation safety through weather conditions, visibility, turbulence, and other atmospheric or physical conditions. Adverse weather, including heavy rainfall, thunderstorms, strong winds, and icing, may affect aircraft handling, flight planning, and landing operations. Poor visibility caused by fog, rain, or dust can make it difficult for pilots to identify runways, terrain, and obstacles, increasing operational risks (Harris & Yu, 2008). Turbulence may cause sudden aircraft movements, injuries, and increased crew workload, particularly when unexpected or severe (ICAO, 2023; IATA, 2026) emphasis the importance of weather monitoring, flight planning, pilot awareness, and safety-risk management in mitigating environmental hazards. In Tanzania, weather and runway conditions are also recognized as aviation safety concerns (TCAA, 2023). However, there remains limited empirical evidence on the specific influence of adverse weather, poor visibility, and turbulence on aircraft crashes in Tanzania, creating a need for the present study.

2.3 Research Gap

The gap addressed in this study is geographical and empirical. Much of the aviation accident literature and institutional reporting is international or regional, while evidence establishing the relationship of the selected human, mechanical, and environmental indicators to crash occurrence in

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Tanzania remains comparatively limited. Local operating conditions, the types of operators represented, professional roles, and the national safety context may affect the relative importance of risk factors. This study therefore uses responses from Tanzanian aviation professionals to estimate relationships among the three constructs and crash occurrence. It does not claim to replace accident investigations or establish causal mechanisms for individual crashes.

2. 4 Conceptual Framework of the Study

The conceptual framework illustrates the relationship between independent variables (factors contributing to aircraft crashes) and the dependent variable (aircraft crashes). This study is grounded in the systems perspective and supported by the Swiss Cheese Model developed by James Reason, which emphasizes that accidents occur due to the interaction of multiple system failures rather than a single cause. In this study, aircraft crashes are influenced by three major categories of factors: human factors, mechanical factors, and environmental factors. These variables interact within the aviation system under the oversight of the Tanzania Civil Aviation Authority.

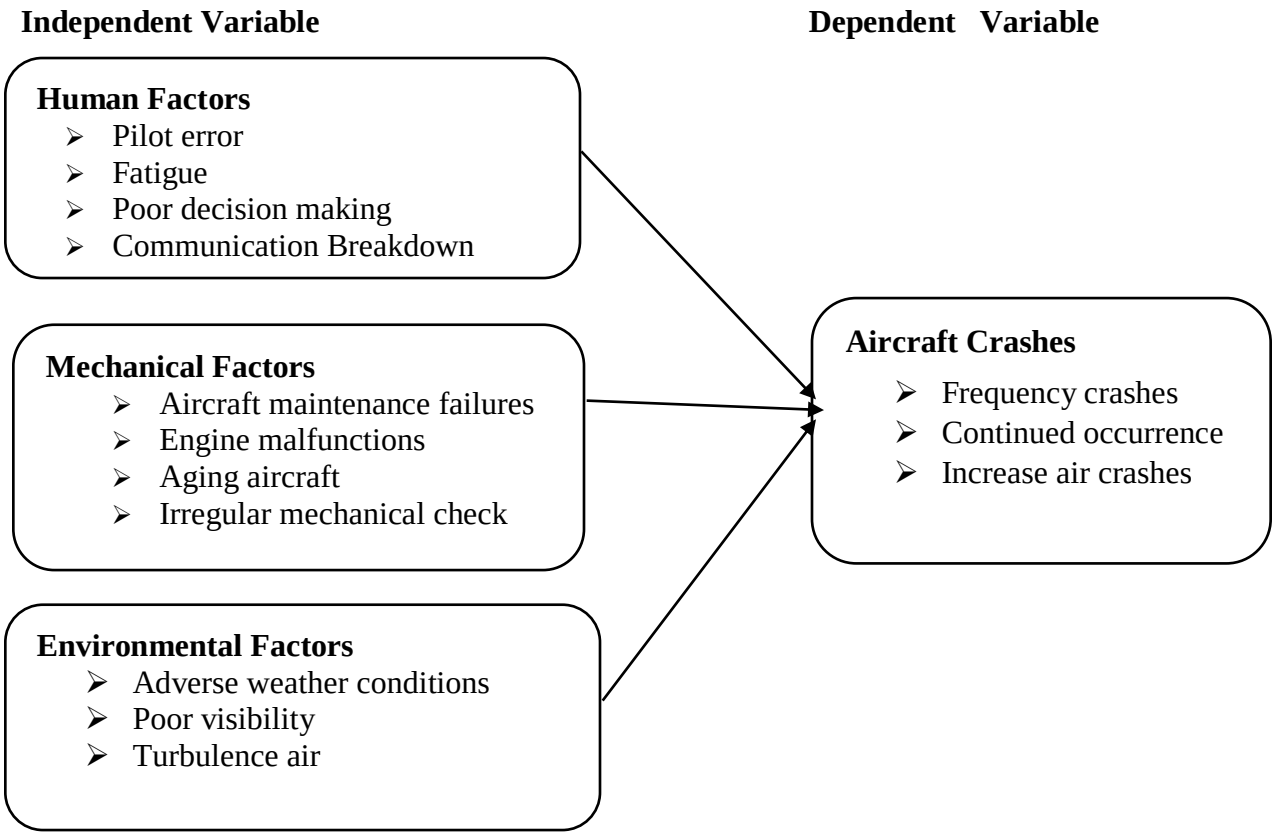

Figure 1: Conceptual Framework
Source: Researcher (2026)

3. Methodology

The study adopted a positivist research philosophy, which emphasizes observable evidence, measurement, and systematic analysis. A deductive approach was applied by examining relationships derived from the study framework through collected questionnaire data. The research design was descriptive and quantitative, allowing responses to be summarized and statistical relationships to be tested.

The study was conducted within Tanzania's aviation industry, focusing on selected airline and aviation organizations and professional groups involved in flight operations, maintenance, dispatch, air traffic control, regulation, and accident investigation. The population was reported as 468 aviation professionals from selected operators and institutions, including ATCL, TGFA, Precision Air, Auric Air, Flight Link, Coastal Aviation, air traffic control, and TCAA safety investigation personnel. Yamane's formula was used to establish a target sample size of 216 respondents. The study obtained 189 valid questionnaires, corresponding to a reported response rate of 87.5%.

The respondents were selected from aviation professional groups whose operational or technical roles could provide relevant experience based perspectives on aviation safety. These included pilots, aircraft maintenance engineers, flight dispatchers, air traffic controllers, and accident investigation staff. The study's findings are therefore based on professional perceptions and questionnaire measures rather than on a direct statistical analysis of individual accident case records. This distinction is important when interpreting the dependent variable, which represents respondents' reported assessment of aircraft crash occurrence.

3.1 Data Collection And Analysis

Primary data were collected using a structured questionnaire. The instrument included demographic questions and Likert-scale statements for human factors, mechanical factors, environmental factors, and aircraft crash occurrence. Respondents rated statements using a five-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Data were processed and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including mean and standard deviation, were used to summarize item level and composite responses. Pearson Product Moment Correlation analysis assessed the direction and strength of relationships among the independent and dependent variables. Multiple linear regression was applied to examine the contribution of human, mechanical, and environmental factors to crash occurrence when the three predictors were entered together. The study used the 5% significance level for individual regression tests, and values below .05 were interpreted as statistically significant.

3.2 Reliability, Validity, And Ethics

3.2.1 Reliability

In this study, the reliability of the questionnaire was assessed using Cronbach's Alpha coefficient, which is commonly used to determine the internal consistency of items measuring the same construct. Cronbach's Alpha was used to assess the internal consistency of questionnaire items measuring technical and mechanical factors and environmental factors influencing aircraft crashes in the aviation industry. A Cronbach's Alpha coefficient of 0.70 or above is generally considered an acceptable level of internal consistency, indicating that the items within a scale are sufficiently correlated and consistently measure the intended construct.

The reliability analysis was conducted using responses from 216 respondents, and no cases were excluded from either reliability analysis. The results indicated that the questionnaire demonstrated acceptable internal consistency for the technical and mechanical factors scale and good internal consistency for the environmental factors scale. These findings suggest that the questionnaire items were sufficiently consistent and suitable for measuring the factors investigated in the study. Therefore, the reliability analysis provided evidence that the research instrument was sufficiently reliable for the collection of data and subsequent statistical analysis. The use of Cronbach's Alpha also strengthened the methodological rigor of the study by demonstrating that the questionnaire items used to measure the respective constructs were internally consistent.

3.2.2 Validity

Validity refers to the extent to which a research instrument measures what it is intended to measure (Creswell et al., 2018). It means high validity ensured that the collected data will represents the concepts under investigation. Validity is ensured mainly through content validity, achieved by developing questionnaire items directly from the theoretical and empirical literature reviewed in Chapter Two, and by having the instrument reviewed by the research supervisor prior to data collection to confirm that the items adequately captured the intended constructs. A pilot test is also conducted with a small group of respondents outside the main sample to check the clarity of the questions before the questionnaire is administered to the full sample.

3.2.3 Ethical Considerations

Research ethics refers to the moral principles that guide a researcher in the design, conduct, and reporting of a study, particularly in relation to the treatment of respondents (Saunders et al., 2019). This study observed the following ethical considerations. First, informed consent is obtained from all respondents. The questionnaire did not require respondents to disclose their names or any other personally identifying information, and the data collected were used strictly for academic purposes. Third, the researcher sought and obtained a research clearance letter from the university, which is presented to relevant authorities and organizations, including Air Tanzania Company Limited (ATCL), Tanzania Government Flight Agency (TGFA), Precision Air, Auric Air, Flight Link, Coastal Aviation Air Traffic Controller (ATC) and TCAA accident investigation staff. Fourth, the study observed academic honesty and integrity by properly acknowledging all sources of information used through citation and referencing, in order to avoid plagiarism. Finally, the data collected were reported honestly and objectively, without misrepresentation of findings, to preserve the scientific integrity of the study.

4. Response Rate

The response rate refers to the proportion of questionnaires that were completed and returned by respondents relative to the total number of questionnaires distributed for the study. In this study, 216 questionnaires were distributed to the selected respondents based on the predetermined sample size. Out of these, 189 questionnaires were completed and returned, while 27 questionnaires were

not returned, resulting in a response rate of 87.5% and 12.55 with no response, as shown in table 4.1 below

Table 4.1: Response Rate

Response Category	Frequency	Percentage (%)
Questionnaires distributed	216	100.0
Questionnaires returned	189	87.5.1
Questionnaires not returned	27	12.5
Total	**216**	**100.0**

Source: Field Data (2026)

4.1 Demographic Characteristics of Respondents

This section presents the demographic characteristics of the 189 respondents who returned usable questionnaires. The characteristics examined were gender, age, organizational affiliation, years of professional experience, and respondents' positions. These characteristics provide a profile of the participants and help establish the professional composition of the respondents whose views were used to examine factors associated with aircraft crashes in Tanzania.

Table 4.2: Demographic Characteristics of Respondents

Demographic Characteristic	Category	Frequency	Percent (%)
Gender	Male	154	82.7
	Female	35	17.3
	Total	**189**	**100**
Age	20–30 years	21	11.1
	31–40 years	76	40.7
	41–50 years	67	35.2
	51 years and above	25	13.0
	Total	**189**	**100**
Airline/Aviation Agency	ATCL	89	43
	TGFA	11	6.8
	Precision Air	30	16.6
	Auric Air	24	13.2
	Flight Link	13	7.3
	Coastal Aviation	15	7.8
	TCAA	7	4.4
	Total	**189**	**100**
Years of Experience	Less than 5 years	10	5.6
	5–10 years	67	35.2
	11–15 years	66	34.6
	Above 15 years	46	24.7
	Total	**189**	**100**
Position	Pilot	102	53.7

Aircraft Maintenance Engineer	38	20.4
Flight Dispatcher	30	16.0
Air Traffic Controller	6	3.7
Aircraft Accident Investigation Staff	13	6.2
Total	**189**	**100.0**

Source: Field Data (2026).

As shown in Table 4.2, 154 respondents (82.7%) were male and 35 (17.3%) were female. Thus, male respondents constituted the larger proportion of the participants. The distribution describes the composition of the respondents who participated in the study and provides an indication of the gender representation within the obtained sample.

With regard to age, 76 respondents (40.7%) were aged 31–40 years, making this the largest age group. This was followed by respondents aged 41–50 years, who accounted for 67 (35.2%), while 25 respondents (13.0%) were aged 51 years and above. The youngest group, comprising respondents aged 20–30 years, accounted for 21 (11.1%). Overall, 189 respondents, equivalent to 88.9%, were aged 31 years or above. This indicates that most participants were within age groups in which respondents would generally have had an opportunity to acquire substantial professional exposure in their respective aviation roles.

In terms of organizational affiliation, ATCL contributed 89 respondents (43%), representing the largest proportion of the sample. TGFA contributed 11 respondents (6.8%), followed by TCAA with 7 respondents (4.4%), Auric Air contributed 24 respondents (13.2%). Flight Link 13 respondents (7.3%). Coastal Aviation14 respondents (7.8%). while Precision Air contributed 24 respondents (14.8%). The distribution shows that the study obtained responses from all four organizations included in the study population. This provided representation of personnel working in airline operations, aviation support activities, and regulatory functions.

Regarding professional experience, 57 respondents (35.2%) had between 5 and 10 years of experience, while 56 respondents (34.6%) had 11–15 years of experience. A further 40 respondents (24.7%) had more than 15 years of experience, whereas only 9 respondents (5.6%) had less than five years of experience. Consequently, 153 respondents (94.4%) had at least five years of professional experience. The high proportion of respondents with five or more years of experience indicates that the study obtained information from participants with considerable exposure to their respective aviation work environments.

The respondents were also distributed across the five professional categories identified in the study. Pilots constituted the largest group, with 87 respondents (53.7%), followed by aircraft maintenance engineers with 33 (20.4%) and flight dispatchers with 26 (16.0%). Aircraft investigation staff accounted for 10 respondents (6.2%), while air traffic controllers accounted for 6 respondents (3.7%). This distribution provided responses from personnel involved in aircraft operation, maintenance, flight coordination, air traffic management, and aircraft accident investigation.

Therefore, demographic results indicate that the 189 respondents represented different professional roles, organizations, age groups, and levels of work experience within the selected aviation sector. The substantial representation of respondents with five or more years of experience, together with the inclusion of the identified aviation professional categories, provided a relevant respondent profile for analyzing the human, mechanical, and environmental factors associated with aircraft crashes in Tanzania.

4.2 Reliability Analysis

Reliability analysis was conducted to establish the internal consistency of the items used to measure the study variables. Cronbach's Alpha coefficient was employed to assess the extent to which the items within each construct consistently measured the same underlying concept. A Cronbach's Alpha coefficient of 0.70 or higher was considered an acceptable indication of internal consistency for the purposes of the study. The reliability results obtained from SPSS are presented in Table 4.3.

Table 4.3: Cronbach's Alpha Reliability Results

Study Variable	Cronbach's Alpha
Human Factors	0.738
Mechanical Factors	0.797
Environmental Factors	0.797
Aircraft Crash Occurrences	0.835

Source: Field Data (2026).

As presented in Table 4.3, all four study variables recorded Cronbach's Alpha coefficients above the 0.70 threshold. Human Factors recorded an alpha coefficient of 0.738, while both Mechanical Factors and Environmental Factors recorded 0.797. Aircraft Crash Occurrence recorded the highest coefficient at 0.835. The coefficients therefore ranged from 0.738 to 0.835, indicating satisfactory internal consistency across the measurement constructs. The results suggest that the items used to

measure the study variables were sufficiently consistent for further statistical analysis. Accordingly, the measurement items were retained for the subsequent descriptive and inferential analyses of the study.

4.3 Descriptive Findings: Human Mechanical Factors Environmental And Crash Occurrence

Human factors were assessed using pilot error, fatigue, poor decision-making, and communication breakdown. The composite mean was 3.28 (SD = .825), suggesting a moderate level of agreement that human-related conditions are associated with aircraft crash occurrence. Communication breakdown had the highest mean (M = 3.35, SD = 1.053), followed by fatigue (M = 3.30, SD = .990), poor decision-making (M = 3.28, SD = 1.011), and pilot error (M = 3.22, SD = 1.008). Item means were close, indicating respondents assessed all four indicators as relevant.

Mechanical factors were assessed through poor maintenance, engine failure, aging aircraft, and irregular inspections. The composite mean was 3.31 (SD = .801), reflecting moderate agreement regarding the role of mechanical conditions. Poor aircraft maintenance recorded the highest mean (M = 3.33, SD = .946), followed by aging aircraft (M = 3.32, SD = 1.084), irregular mechanical inspection (M = 3.30, SD = .990), and engine failure (M = 3.29, SD = 1.073). The narrow range of item means suggests respondents viewed the mechanical indicators similarly.

Together, the descriptive results indicate moderate respondent agreement about the relevance of human and mechanical risk factors. These measures reflect professional perceptions of safety risks rather than independently verified frequencies of technical defects or human errors in recorded accidents.

Environmental factors were assessed using bad weather, poor visibility, turbulence, and aerodrome location. The composite mean was 3.29 (SD = .813), indicating moderate agreement that environmental conditions are associated with crash occurrence. Poor visibility recorded the highest mean (M = 3.36, SD = .969), followed by aerodrome location (M = 3.33, SD = .996), turbulence (M = 3.30, SD = 1.045), and bad weather (M = 3.17, SD = .963). The item results suggest that respondents placed comparatively higher emphasis on visibility and aerodrome location, while still considering all environmental indicators relevant.

The crash occurrence construct was also measured through questionnaire items about the occurrence and frequency of aircraft crashes in Tanzania and perceptions of aviation safety. The questionnaire-based outcome is interpreted as respondents' reported assessment of crash occurrence, not a verified accident-count series. This distinction matters because perceptions and official accident records measure different things.

Descriptive analysis provided an overview of respondents' ratings and the consistency of responses. Human, mechanical, and environmental composite means were all above the midpoint of the five-point response scale, and the means were relatively close. This suggests that the respondent group recognized the relevance of all three dimensions, rather than viewing crash occurrence as attributable to one single category. The inferential analysis was subsequently used to assess whether the constructs were statistically associated with the dependent measure and whether their relationships remained significant when modeled simultaneously.

4.4 Correlation Analysis

Pearson correlation analysis examined the direction and strength of relationships among the study variables. Human factors were positively correlated with aircraft crash occurrence ($r = .376$, $p < .001$). Mechanical factors also had a positive relationship with crash occurrence ($r = .415$, $p < .001$). Environmental factors recorded the largest bivariate correlation with crash occurrence ($r = .439$, $p < .001$). These results indicate that higher scores on each risk-factor construct were associated with higher reported crash-occurrence scores.

Correlations among the independent variables were comparatively low. Human factors correlated with mechanical factors at $r = .141$ ($p = .074$) and with environmental factors at $r = .127$ ($p = .107$); neither relationship was statistically significant at the 5% level. Mechanical and environmental factors were weakly positively correlated ($r = .163$, $p = .039$). The relatively low intercorrelations suggest that the predictors capture related but distinct dimensions in the sample.

The correlation results provide initial support for all three study objectives. Environmental factors had the strongest bivariate relationship with crash occurrence, followed by mechanical and human factors. Correlation does not establish causation, and the results should not be interpreted as evidence that the questionnaire ratings identify the cause of any individual crash. Regression

analysis was used to examine the contribution of each factor while controlling for the other predictors.

4.5 Regression Analysis

Multiple linear regression was conducted with aircraft crash occurrence as the dependent variable and human, mechanical, and environmental factors as simultaneous predictors. The model summary reported R = .628, R^2 = .394, adjusted R^2 = .382, standard error of estimate = .52021, and Durbin–Watson = 1.935. The R^2 value indicates that the model accounted for 39.4% of the variance in the crash-occurrence measure, while adjusted R^2 was 38.2%.

The ANOVA table reported a statistically significant overall model, $F(9, 180) = 34.226$, $p < .001$, indicating that the predictor set was significantly associated with the dependent measure. The regression coefficients were positive and statistically significant. Human factors had B = .230, β = .287, t = 4.565, $p < .001$. Mechanical factors had B = .262, β = .317, t = 5.011, $p < .001$. Environmental factors had B = .286, β = .351, t = 5.566, $p < .001$.

The standardized coefficients indicate the relative contribution of each predictor within the fitted model. Environmental factors had the largest beta, followed by mechanical and human factors. Tolerance values ranged from .959 to .969 and VIF values from 1.032 to 1.043, suggesting no serious multicollinearity issue.

5. Discussion

The findings indicate that human, mechanical, and environmental factors were each positively and significantly associated with aircraft crash occurrence in the study sample. This supports a systems oriented view of aviation safety, in which operational outcomes may reflect interactions among personnel, aircraft condition, and external conditions. The statistical evidence is consistent across correlation and regression analyses, although the magnitudes of the relationships differ.

Human factors were significantly associated with crash occurrence. The descriptive results emphasized communication breakdown, fatigue, decision making, and pilot error as closely rated concerns. Aviation operations rely on coordination across flight crews, dispatch, maintenance, air traffic control, and safety personnel. Fatigue may affect attention and decision quality, while

communication breakdown can lead to incomplete, misunderstood, or delayed information. Training, crew resource management, procedural discipline, and fatigue management remain important safety interventions.

Mechanical factors were also significant, with poor maintenance receiving the highest descriptive mean among mechanical indicators. Aircraft depend on the airworthiness of systems and components and on maintenance processes that detect defects, carry out repairs, and document work. Engine failure and aging aircraft were rated similarly to inspection concerns, reinforcing the importance of preventive maintenance, technical competence, and quality assurance. Aircraft age should not be interpreted in isolation; safety depends on the aircraft's condition and maintenance regime.

Environmental factors had the strongest standardized coefficient. Visibility and aerodrome location received comparatively higher descriptive ratings. Weather, turbulence, terrain, runway conditions, and visibility can affect flight planning, approach and landing, and crew workload. These risks require accurate weather information, careful operational assessment, and adherence to flight limitations. The results imply that environmental risk management deserves focused attention while being coordinated with human and technical safety measures.

6. Conclusion And Recommendations

Overall, the study concludes that human factors, mechanical factors, and environmental factors are significant predictors of aircraft crash occurrence in the aviation industry in Tanzania. The three factors jointly explained 70.1% of the variation in aircraft crash occurrence, demonstrating substantial explanatory power. Mechanical factors emerged as the strongest predictor, followed by human factors and environmental factors. The study therefore concludes that aircraft crashes should not be addressed through a single dimensional safety strategy. Rather, effective accident prevention requires an integrated aviation safety approach that simultaneously addresses aircraft technical reliability, human performance, and environmental risks. The remaining 29.9% of unexplained variation indicates that other factors outside the scope of the present study may also contribute to aircraft crash occurrence.

Recommendations

For human factors, aviation operators should strengthen recurrent training, crew resource management, communication and coordination practices, situational awareness, decision-making, and adherence to standard operating procedures. Fatigue risk should be managed through appropriate scheduling, monitoring, reporting, and organizational controls.

For mechanical factors, operators should ensure preventive maintenance is planned and completed, inspection intervals are respected, defects are recorded and rectified, and maintenance personnel have appropriate competence and resources. Technical quality assurance and oversight should support the reliability of aircraft systems. Aircraft age should be assessed alongside condition, maintenance history, and airworthiness status.

For environmental factors, operators and relevant authorities should improve use and dissemination of weather information, visibility and runway condition assessment, route and aerodrome risk evaluation, and operational decision-making in adverse conditions. The regulator should continue risk based oversight and encourage reporting and learning. Future research should use verified accident and incident databases, larger or broader samples, longitudinal analysis, and mixed methods to examine how the factors interact and to test the findings beyond respondent perceptions.

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